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OF

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VOLUME XIX.

NINETEENTH SESSION, 1902-1903.

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ERRATUM.

Graduate Section, Page 7, Line 11, read Mr. George Robson in place of Mr. R. Robson.

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Berechnung und Konstruktion der Schiffsmaschium-und-Kessel. Dr. G. Bauer. 1902.
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The Right Honourable the Earl of Glasgow, G.C.M.G., LL.D., Fairlie Craig, Fairlie, Ayrshire	April 1902

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A.

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Armstrong, Joseph, 4, Salem Avenue, Sunderland ... ... (S) Nov. 1892
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Bagnall, T. W., The Groves, Winlaton ... ...(F M) Nov. 1893
Bailey, Charles H., Tyne Engine Works, Newport, Mon. ... ... (E) Mar. 1896
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Bailey, James T., c/o Messrs. Swan Hunter & Wigham Richardson, Ltd., Neptune Works, Low Walker ... ... (E) Feb. 1899

ELECTED.

Baines, Geo. Henry, c/o Messrs. W. Gray & Co., Central Marine Engine Works, West Hartlepool ... ... (E) Oct. 1888

Baird, Alexander, 23, Roxburgh Terrace, Whitley Bay ... ... (E) Oct. 1898

Baird, George, 24, Cecil Street, North Shields ... ... (E) Oct. 1892

Baird, Robert, 13, Hylton Terrace, North Shields ... ... (E) Jan. 1890

Baker, E. F., R.N., 47, Radcliffe Square, South Kensington, London, E.C. ... ... (E) { Graduate, Nov. 1892 / Member, Feb. 1898

Barber, Wm. Daglish, 69, Elswick Row, Newcastle-upon-Tyne ... (S) Oct. 1902

Barclay, James, Lloyd's Register of Shipping, Swansea ... ...(SUR) Nov. 1888

Barley, C. J., c/o Messrs. The London Electric Supply Corporation, Stowage Wharf, Deptford, London, S.E. ...(E) { Graduate, Feb. 1885 / Member, Dec. 1886

Barrett, A., Highfield, Hutton Avenue, West Hartlepool ... (E) May 1896

Barron, T. G., Hobourne, Elswick Road, West Hartlepool ... (E) Oct. 1888

Bateman, John, Vane Terrace, Darlington ... ... (E) Mar. 1901

Batey, John Thomas, 52, Queen's Road, Jesmond, Newcastle-upon-Tyne ... ... (S) Nov. 1885

Batliboi, Jehangir Framji, 45, Forbes Street, Fort, Bombay ... (E) Dec. 1888

Baxter, J., 26, Simonside Terrace, Heaton, Newcastle-upon-Tyne (E) Nov. 1884

Beadon, D. C., "Stoneham," Beech Grove Road, Newcastle-upon-Tyne... ... ... (E) Jan. 1885

Beckett, Frank, 119, Gorton Road, Reddish, near Stockport ... (E E) Dec. 1901

Bell, Geo. Arthur, 48, Crown Street, Newcastle-upon-Tyne (E) { Graduate, Oct. 1890 / Member, Jan. 1894

Bell, Joshua Robson, 40, Hill Street, Jarrow-on-Tyne ... ... (S) Mar. 1899

Bell, William, Messrs. Cleland's Slipway Co., Willington Quay-on-Tyne ... ... (E) Nov. 1888

Bennett, Percy M., Gore Court, G., Calle de Roma, Mexico City ... (E E) Dec. 1899

Berkley, A. B., 9, Camden Terrace, Clifton Vale, Bristol ... ... (E) Mar. 1887

Bertram, N. Stewart, c/o Messrs. Lillishall & Co., engine Depart., Oakingates, Shropshire ... ... (E) { Graduate, Feb. 1901 / Member, Oct. 1902

Berven, Ferdinandt, c/o Messrs. Bergens Mekaniske Værksted, Bergen, Norway ... ... (S) April 1901

Bigge, D. L. Selby, 27, Mosley Street, Newcastle-upon-Tyne ... (E E) Nov. 1894

Billetop, Torben Christian, Springfield, Lesbury Road, Heaton, Newcastle-upon-Tyne ... ... (E) Nov. 1896

Bindesböll, S. C. W., Aktieselskabet Helsingors Jernskibs- og Maskinbyggeri Helsingor, Denmark ... ... (S) Nov. 1884

Binns, Aubrey B., 23, Thornhill Terrace, Sunderland ...(E) { Graduate, Oct. 1894 / Member, Dec. 1899

Black Charles, c/o Messrs. Vacuum Oil Co., Ltd., 7, Side, Newcastle-upon-Tyne ... ... (E) Oct. 1902

Black, J., 1, Church Street, West Hartlepool ... ... (E) Nov. 1888

Black, Wm., 1, Lovaine Place, Newcastle-upon-Tyne ... ... (E) Jan. 1885

Blackett, Jos. S., c/o Messrs. Smith's Dock Co., Ltd., North Shields (E) May 1903

Blackett, Walter, c/o Messrs. Hawthorn, Leslie & Co., St. Peter's Works, Newcastle-upon-Tyne ... (E) { Graduate, Nov. 1886 / Member, Nov. 1892

Blackie, Thomas Reid, Lloyd's Register of Shipping, 71, Fenchurch Street, London ... ... (SUR) Nov. 1890

Bladon, Jas. Buckley, 12, Havelock Street, Newcastle-upon-Tyne (E) Nov. 1901

Blake, James, Northbrook, Linthorpe, Middlesbro' .. ... (E) Nov. 1899

Blaylock, Robert, 10, Greenbank Crescent, Darlington ... ...(F M) Dec. 1900

ELECTED.

Blenkinsop, John N., Marine Supt. Engineer, Great-Eastern Railway, Parkeston Quay ... ... (E) Oct. 1885

Blomberg, Carl A., 2262, North 19th Street, Philadelphia. Pa., United States of America ... ... (E) Oct. 1896

Blow, Charles, Beech Grove, Benton, Newcastle-upon-Tyne ... (E) Nov. 1898

Blumer, Wm., Ashbrooke Tower, Sunderland ... ... (S) Dec. 1886

Böcler, Harry, 19. Azalea Terrace South, Sunderland (S) { Graduate, Mar. 1898 / Member, Dec. 1901

Boddy, John, 96, Dock Street, Newport, Monmouthshire ... ... (E) Dec. 1888

Bodin, Lauritz M., 58, John Street, Sunderland ... ... (E & SUR) Dec. 1889

Bone, W. J., 61, Linskill Terrace, North Shields ... ... (S) Dec. 1884

Bonnyman, James Smith, 64, Plasturton Avenue, Cardiff... ... (E) Nov. 1889

Boolds, Jas. H., c/o Messrs. Vickers, Sons, & Maxim, Naval Construction Works, Barrow-in-Furness ... ... (S) Oct. 1886

Booth, Edward Spence, Box 5124, Boston, U.S. America ...(M S & N A) Oct. 1889

Borrie, Peter, 4, Oxford Terrace, Stockton-on-Tees... ... ... (E) Nov. 1900

Borrowman, William Cameron, Wh.Sch., Strathmore, West Hartlepool ... ... (E) Oct. 1895

Bosi, Guiseppe, Presso Rastelli, Sampierdarena, Genoa, Italy (E & NA) Jan. 1894

Bowden, John, Sheriff Mount, Gateshead-on-Tyne (E) { Graduate, Jan. 1894 / Member, Oct. 1898

Bowerbank, Albert W., 52, Victoria Avenue, Whitley Bay, Northumberland ... ... (E) { Graduate, Nov. 1900 / Member, Dec. 1902

Boyd, Arthur, Lloyd's Register of Shipping, Bute Docks, Cardiff(E SUR) May 1895

Boyd, Wm., North House, Long Benton, Newcastle-upon-Tyne ... (E) Nov. 1884

Boyt, John T., 387, Bourse Buildings, Philadelphia, Pa., U.S.A. ... (E) Nov. 1893

Bramwell, Balfour, 4, Victoria Crescent, Ravenhill Road, Belfast ... ... (E) { Graduate, Nov. 1886 / Member, Nov. 1887

Brankston, R. T., Beechcroft, Beechgrove Road, Newcastle-upon-Tyne ... ... (E) Nov. 1884

Brew, George, c/o Messrs. Furness, Withy & Co., steamship owners, Montreal ... ... (SUR & C E) May 1896

Brigham, Robert F., 5, Argyle Terrace, South Shields ... ... (E) Mar. 1897

Broadbent, Frank, c/o 5, Bond Court, Wallbrook, London, E.C. ... (E E) Nov. 1893

Brock, Henry W., c/o Messrs. Wm. Denny & Bros., Dumbarton (E & S) Nov. 1899

Brockett, Charles, 35, Milton Road, West Hartlepool ... ... (E) Feb. 1899

Brotherston, James, 23, Nelson Street, Sunderland ... ... (E) Oct. 1895

Brown, Eugene, c/o Messrs. J. H. Holmes & Co., Portland Road, Newcastle-upon-Tyne ... ... (E E) Feb. 1886

Brown, Geo. Matthew, c/o Messrs. The British Thompson-Houston Co., Rugby ... ... (E) { Graduate, April 1895 / Member, Nov. 1897

Brown, James, c/o Messrs. Scott & Co., Greenock ... ... (E) Mar. 1891

Brown, Percy J., Salem Cottage, Sunderland ... ... (E) May 1899

Brown, Robson, 32, Salmon Street, South Shields ... ... (E) Nov. 1889

Brown, T. R., 37, Stansfield Street, Sunderland ... (E) { Graduate, May 1885 / Member, Oct. 1886

Brown, William, c/o Messrs. Siemens Brothers & Co., Woolwich... (E) April 1887

Browne, Benjamin C., jun., 8, Lambton Road, Newcastle-upon-Tyne ... ... (E) { Graduate, Oct. 1898 / Member, Dec. 1901

Browne, Sir B. C., Westacres, Benwell, Newcastle-upon-Tyne (C E) Jan. 1885

Buchanan, John H., Oswald Chambers, 5, Oswald Street, Glasgow(SUR) Oct. 1888

ELECTED.

Buckland, H. B., Baltic Chambers, Quayside, Newcastle-upon-Tyne (E) Nov. 1885
Buckwell, George William, Board of Trade Surveyor's Offices, Barrow-in-Furness ... ...(SUR) Oct. 1896
Bull, John Catharinus, Athelstane, Helensburgh ... ... (E) Oct. 1892
Bulmer, A. E., Jesmond Lodge, Gidlow Avenue, Wigan (E) { Graduate, Nov. 1895 / Member, Nov. 1901
Bulmer, Frederick Charles, 29, Benwell Grove, Benwell, Newcastle-upon-Tyne ... ... (E) { Graduate, May 1894 / Member, Oct. 1895
Bulmer, John, 2, Graingerville North, Newcastle-upon-Tyne ... (E) Mar. 1886
Bulmer, John George, 34, Brighton Grove, Newcastle-upon-Tyne (E) May 1894
Bulmer, Septimus, 49, Brighton Grove, Newcastle-upon-Tyne... ... ... (E) { Graduate, May 1894 / Member, Dec. 1899
Burbidge, Alfred H., Backwell Rectory, Bristol ... (E) { Graduate, Oct. 1895 / Member, Oct. 1898
Burgess, Norval Henry, 46, North View, Heaton, Newcastle-upon-Tyne ... ... (S) { Graduate, Dec. 1901 / Member, Dec. 1902
Burley, M. F., 14, Croft Terrace, Jarrow-on-Tyne ... ... (F) Nov. 1899
Burnett, Norman, C, Lombard Street, Newcastle-upon-Tyne ... (E) Oct. 1891
Bushell, Chas. A., 1, Benton Terrace, Newcastle-upon-Tyne (N A & SUR) Nov. 1893
Butterfield, George, 4, Kayll Road, Sunderland ... ... (S) Nov. 1884
Butterworth, George Herbert, 41, Brook Road, Bootle, nr. Liverpool (E) Nov. 1899
Byers, Charles, 10, The Avenue, Sunderland ... ... (E) Nov. 1902
Bryers, Wm. Lumsden, 11, Norfolk Street, Sunderland .. ... (E) May 1900

C.

Cairns, C. W., M.Sc., c/o Mrs. Robson, 11, Beaumont Terrace, Gosforth, Newcastle-upon-Tyne ... ... (E) { Graduate, Nov. 1894 / Member, Dec. 1897
Carr, Ralph, jun., 19, Abingdon Street, Westminster, London, S.W. ... ... (E) { Graduate. Jan. 1894 / Member, Nov. 1901
Carr, Wilson Story, Collingwood Buildings, Newcastle-upon-Tyne (C E) May 1900
Cama, Nusserwanji Bomanji, Sleater Road, Tardeo, Bombay, British India ... ... (E) Dec. 1888
Cameron, Angus, c/o Messrs. Sir James Laing & Sons, Deptford Yard, Sunderland ... ... (S) Nov. 1892
Cameron, Hugh Robert, 1, York Terrace, North Shields ... ... (E) Feb. 1903
Campbell, Thomas, 129, Bute Road, Docks, Cardiff ... ... (S) Mar. 1894
Canning, Chas. E., 29, Duan Terrace, Ryton-on-Tyne (S) { Graduate, Dec. 1897 / Member, Nov. 1899
Cannell, Frank, Messrs. H. Parry & Son, Lisbon ... ... (E & S) Nov. 1887
Carnegie, Alfred Q., 21, Eldon Place, Newcastle-upon-Tyne ... ... (EE) { Graduate, Nov. 1899 / Member, Dec. 1901
Carney, J. H., Glengariffe, Stow Park, Newport, Monmouth ... (E) Mar. 1897
Carney, W. H., c/o Messrs. Port Talbot Graving Dock, Port Talbot (S) Oct. 1902
Carstons, Samuel, Messrs. Burmeister & Wains, Maskin-og Skibsbyggeri, Copenhagen, Denmark... ... ... (S) Dec. 1887
Carter, Geo. J., c/o Messrs. Sir W. G. Armstrong, Whitworth & Co., Elswick Shipyard, Newcastle-upon-Tyne ... ...(N A) Dec. 1897
Ceuvel, John L., 763, Gulgenstug, Naarden, Holland ... ... (E) Mar. 1886
Chambers, John, 114, Sidney Grove, Newcastle-upon-Tyne ... (E) Dec. 1897
Chapman, Harry Reynolds, Messrs. Clarke, Chapman & Co., Gateshead-on-Tyne ... ... (E) Mar. 1893

ELECTED.

Charlton, T., 25, Lincoln Street, Gateshead-on-Tyne ... ... (E) Nov. 1884
Chaston, Edward Catmore, 36, St. George's Terrace, Newcastle-upon-Tyne ... ... (E) Oct. 1894
Cherry, Thos. Wm. Fry, c/o Messrs. Tyne General Ferry Co., St. Peter's, Newcastle-upon-Tyne ... ... (E) Oct. 1894
Chicken, Christopher B., 169. Hampstead Road, Newcastle-upon-Tyne ... ... (E) Dec. 1901
Chicken, Thomas. c/o Messrs. Newport Engineering and Ship Repairing Co., Newport. Monmouth ... ... (E) Oct. 1892
Chilton, Joseph, 73, Theresa Street. Blaydon-on-Tyne ... ... (E) Dec. 1899
Chisholm, Alexander, c/o Messrs. The Sunderland Shipbuilding Co., Sunderland ... ... (S) Mar. 1893
Christie, C. J. D., Neptune Works. Walker-on-Tyne ... ... (S) Nov. 1884
Christie, David M., 95, Great Western Road, Glasgow ... ... (E) Mar. 1900
Christie, J. D., Woodside, Tynemouth ... ... (S) Nov. 1884
Christie, Reginald, Woodside, Tynemouth ... ... (E E) Mar. 1900
Clark, Charles, c/o Messrs. Robert Irvine & Co., Tower Chambers, West Hartlepool .. .. (E) Jan. 1897
Clark, George, Southwick Engine Works, Sunderland ... (E) Feb. 1888
Clark, Henry, Southwick Engine Works. Sunderland ... ... (E) Oct. 1887
Clark, John Harwood, Messrs. Sir James Laing & Sons, Deptford Yard, Sunderland ... ... (E) Nov. 1901
Clarke, Harry, Lloyd's Register of Shipping, Bank Chambers, Newport, Monmouth ... ... (E) Mar. 1897
Clarke, Henry Trevisa, Deptford Shipyard, Deptford, Sunderland (S) Mar. 1892
Clarke, William Henry, 21, The Terrace. Roker, Sunderland ... (E) Dec. 1896
Cleghorn, Alexander, 10, Whittinghame Drive, Kelvinside, Glasgow ... ... (E) Feb. 1897
Coates, Matthew C., 26, Denmark Street, Gateshead-on-Tyne ... (E) Nov. 1897
Cohn, William M., 2, Marine Terrace, North Shields ... ... (S) Nov. 1893
Coleby, James W., Churchill Street, Willington Quay-on-Tyne ... ... (E) { Graduate. Oct. 1891 / Member, Jan. 1894
Collins, Edward D., 5, Albert Terrace, Whitley Bay, Northumberland ... ... (E) Feb. 1903
Common, John B. A., Lloyd's Register of Shipping, 71, Fenchurch Street, London, E.C. ... ... (E) April 1896
Coninck. Gastin de, 2, Summerhill East, Sunderland ... ... (S) April 1902
Conradi, Carl, Prinsens Gade 2b, Christiania, Norway ... ... (E) Nov. 1884
Consiglio, Luigi, 8, Via Paterno, Palermo ... ... (N A) Nov. 1890
Cookson, John A., 2, St. Edmund's Road, Gateshead-on-Tyne ... ... (E) { Graduate, Dec. 1895 / Member, Nov. 1897
Cookson, William D., Milton House, Albert Drive, Low Fell, Gateshead-on-Tyne ... ... (E) Nov. 1901
Cooper, Burjorjee S. N., Sea View, Mahim, Bombay, British India (E) May 1900
Cooper, Shapcojee P., Luxmi Mills, Sholapur, British India ... (E) Apl. 1903
Coote, Arthur, Messrs. R. & W. Hawthorn. Leslie, & Co., Hebburn-on-Tyne ... ... (S) Nov. 1884
Cornish, H. P., Lloyd's Register of Shipping, 28, Kattendyk, Ouest Quai, Antwerp ... ... E) Oct. 1888
Couche, Henry Drew, c/o Messrs. Laird Bros., Birkenhead Works, Birkenhead ... ... (S) Oct. 1891

ELECTED.

Coull, Alex. B., Baltic Chambers, Newcastle-upon-Tyne ... ... (C E) Jan. 1898

Coulson, Richard H. A., 12, East View, South Shields (E) { Graduate, April 1897 / Member, Dec. 1901

Courtier-Dutton, W. T., British Corporation Registry of Shipping, 121, St. Vincent Street, Glasgow ... ... (S SUR) April 1890

Cowan R., 14, Osborne Avenue, South Shields ... ... (E) Dec. 1896

Cowens, William Edward, c/o Messrs. John Abbot & Co., Gateshead-on-Tyne ... ... (E) Dec. 1889

Craggs, Adolphus, Ivy House, Pelton, Chester-le-Street (E) { Graduate, Dec. 1897 / Member, Nov. 1899

Craggs, Ernest H., Messrs. R. Craggs & Sons, Tees Dockyard, Middlesbrough ... ... (S) Oct. 1888

Craig, Robert, Pageland House, Grange Road, West Hartlepool ... (E) Nov. 1892

Crighton, A. T., 27, Canal des Brasseurs, Antwerp ... ... (E) Apl. 1903

Crookston, John, 72, Mark Lane, London, S.E. ... ... (E) Mar. 1896

Crozier, Thomas W., c/o Messrs. Blyth Shipbuilding Co., Blyth ... (S) Dec. 1902

Cruddas, W. D., Messrs. Sir W. G. Armstrong, Whitworth & Co., Ltd., Elswick, Newcastle-upon-Tyne ... ... (E) Dec. 1884

Cruickshank, Alexander, H.M. Naval Dockyard, Gibraltar .. (SUR) Mar. 1892

Cullen, Harold Rigby, Durham College of Science, Newcastle-upon-Tyne ... ... (E) Nov. 1902

Cumming, William, c/o Mr. Hyslop, Hampton House, Grey Street. St. Kilda, Melbourne, Australia ... ... (E) Mar. 1896

Cummins, W. R., 15, Western Elms Avenue, Reading, Berkshire (E) Nov. 1884

D.

Dale, John, 13, Rwesley Road, Chester Road, Sunderland ... (E) Mar. 1897

Dalrymple, Alexander, 25, Rutland Avenue, Sefton Park, Liverpool (E) Nov. 1901

Dalrymple, Wm., Myrtle Cottage, nr. Cleadon, Sunderland ... (E) Dec. 1886

Dalrymple, William, Jun., 42, Cleveland Road, Sunderland ... (E) Dec. 1895

Danielsen, John William, Highfield, Farquhar Road, Birmingham... ... ... (E) { Graduate, Mar. 1899 / Member, Mar. 1902

Darling, W. J., Lloyd's Register of Shipping, Dock Chambers, Barry ... ... (S) April 1887

Darney, John, c/o Messrs. Short Bros., Pallion, Sunderland ... (S) Nov. 1884

Davidson, Alexander, 12, Hayburn Crescent, Partick, Glasgow ... (E) Nov. 1900

Dawson, Thomas Charles, c/o Messrs. Baird Bros., Bull Ring Engine Works, North Shields ... ... (E) May 1902

Deighton, William, Messrs. Deighton's Patent Flue Co., Vulcan Works, Pepper Road, Leeds ... ... (E) Nov. 1897

Denny, Archibald, c/o Messrs. Wm. Denny & Bros., Dumbarton ... (S) Dec. 1891

Denny, Leslie, c/o Messrs. Wm. Denny & Bros., Dumbarton ... (S) Nov. 1899

Denny, Peter, Bellfield, Dumbarton... ... ... (E & S) Nov. 1899

De Rusett, Edwin W., Warden House, Percy Park Road, Tynemouth ... ... (S) Nov. 1890

Detchon, John, Bamborough Terrace, North Shields ... ... (E) Feb. 1899

Dick, F. W., c/o Messrs. Park Gate Iron and Steel Co., Ltd., Park Gate, Rotherham ... ... (I & S M) Oct. 1891

Dickie, James, Falstone House, West Park, South Shields ... (S) Nov. 1901

Dickie, James, 428, Mississippi Street, Potrero, San Francisco, California, U.S.A. ... ... (S) Mar. 1894

ELECTED.

Dickie, John P., Falstone House, West Park, South Shields ... ... (E) — Graduate, Mar. 1898; Member, May 1900

Dickie, Matthew D., Falston House, West Park, South Shields ... (S) Jan. 1903

Dickinson, F. T., Ashbrook Crescent, Sunderland (E) — Graduate, May 1885; Member, Oct. 1886

Dickinson, James C., The Cloisters, Sunderland ... ... (E) Nov. 1884

Dickinson, John, Park House, Sunderland ... ... (E) Nov. 1884

Dickinson, W., The Club, Sunderland ... ... (E) Nov. 1884

Dietze, F. G., Messrs. The Hamburg South American Steam Ship Company, Hamburg ... ... (E) Nov. 1893

Dippie, Joseph Robt., 130 Albert Road, Jarrow-on-Tyne ... ... (S) April 1900

Dixon, Harold Raylton, Messrs. Sir Raylton Dixon & Co., Ltd., Shipbuilders, Middlesbrough ... ... (S) May 1902

Dixon, James, c/o Messrs. Ropner & Sons, Shipbuilders, Stockton-on-Tees ... ... (E) Dec. 1893

Dixon, John Rochester, 4, St. Nicholas's Buildings, W., Newcastle-upon-Tyne ... ... (E) — Graduate, Oct. 1887; Member, Feb. 1893

Dixon, John Thomas, 27, Meldon Terrace, Heaton, Newcastle-upon-Tyne ... ... (E) — Graduate, Dec. 1899; Member, Dec. 1901

Dixon, William John, R.N., H.M.S. "Bacchante," Mediterranean Squadron ... ... (E) — Graduate, Mar. 1896; Member, Nov. 1899

Dobson, Henry James, c/o Messrs. William Dobson & Co., Newcastle-upon-Tyne ... ... (S) — Graduate, Oct. 1891; Member, Feb. 1898

Dobson, Wm. G., The Chesters, Jesmond, Newcastle-upon-Tyne ... ... (S) — Graduate, Feb. 1896; Member, Dec. 1901

Dobson, William, Shipbuilder, Walker-on-Tyne ... ... (S) Nov. 1888

Donald, James, 58, General Gordon Terrace, Sunderland ... ... (S) Nov. 1884

Donaldson, Henry B., c/o Messrs. Sir Raylton Dixon & Co., Cleveland Shipyard, Middlesbro'-on-Tees ... ... (S) Dec. 1902

Donkin, George, St. Andrew's Engine Works, Newcastle-upon-Tyne (E) Oct. 1892

Donovan, J. W., 5, Ash Place, Newcastle Road, Sunderland ... (E) April 1885

Dos Santos, Apolinaris J., Rua Coronel, Sampaio 59, Rio Grande-do-Sul, Brazil ... ...(SUR) Nov. 1891

Douglas, John F., c/o Messrs. Ramage & Ferguson, Leith... ... (E) Jan. 1888

Dove, Herbert J., 14, Lyndhurst Avenue, Jesmond, Newcastle-upon-Tyne ... ... (E) Nov. 1896

Downing, Nicholas, Glenbrooke, Victoria Avenue, Norton Road, Stockton-on-Tees ... ... (I F) Oct. 1894

Dowsen, Chas., 21, Croft Terrace, Jarrow-on-Tyne... ... ... (E) Dec. 1885

Dowsen, Jas. Wm., 21, Croft Terrace, Jarrow-on-Tyne ... ... (E) May 1903

Doxford, Albert Ernest, M.A., 1, Grange Crescent, Sunderland... ... ... (E) — Graduate, Oct. 1890; Member, Nov. 1893

Doxford, Charles D., Pallion Shipyard, Sunderland ... ... (S) Nov. 1884

Doxford, Robt., jun., Silksworth Hall, Sunderland (S) — Graduate, Feb. 1897; Member, Dec. 1901

Doxford, Robert P., Pallion Engine Works, Sunderland ... ... (E) Nov. 1884

Doxford, Sir W. Theodore, M.P., Pallion Shipyard, Sunderland ... (S) Nov. 1884

Dressler, Gustav, 21, Fischmarkt, Altrona-on-Elbe ... ... (E) Jan. 1900

Duckitt, Jno., Leazes Gate Villa, Newcastle-upon-Tyne ... ... (E) Nov. 1884

Duckitt, John Brentnall, 179, Great Norbury Street, Hyde, Cheshire ... ... (E E) — Graduate, Oct. 1888; Member, April 1895

ELECTED.

Duckitt, Talbot, Hawthorndale Cottage, Paton Street, Alloa, N.B. ... ... (E E) Graduate, Oct. 1891; Member, Oct. 1898

Dudgeon, F. S., 30, Great St. Helens, London, E.C. ... ... (E) Feb. 1885

Dugdale, William H., Wear Dock Yard, Sunderland ... ... (S) Mar. 1894

Duguid, Robert, c/o Messrs. Harland & Wolff, Drawing Office Department, Belfast ... ... (S) Oct. 1892

Dunlop, John, c/o Messrs. Scott & Co., Shipbuilders, Dockyard, Greenock ... ... (S) Mar. 1898

Dunlop, William, c/o Messrs. Odero fu Alessº., Sestri-Ponente, Italy (E) Mar. 1888

Dykes, George, Lloyd's Register of Shipping, Steinhoeft 3, Hamburg ... ... (S) Jan. 1893

Dykes, James, 82, Park Road, Newcastle-upon-Tyne ... ... (E) May 1885

Dykes, John, Lloyd's Register of Shipping, 12, Oriel Chambers, Liverpool ... ...(SUR) Oct. 1889

E.

Eason, Thos., 30, Rothwell Road, Gosforth, Newcastle-upon-Tyne (E) April 1899

Edminson, Frank A., Gowan Villas, Newcastle-upon-Tyne (S) Graduate, Nov. 1893; Member, Nov. 1897

Edmiston, Jas. B., Ivy Cottage, Highfield Road, Walton, Liverpool (E) Nov. 1886

Edwards, Robert Wm., Eng. Captain, R.N., c/o Mail Officer, H.M.S. "Hibernia," Malta ... ... (R N E) Feb. 1902

Eeles, Robert, Cathedral Buildings, Dean Street, Newcastle-upon-Tyne... ... ... (E) April 1889

Elder, Edward, c/o Messrs. Frew, Elder, & Co., 9 Queen Street, Newcastle-upon-Tyne ... ... (S) Graduate, Nov. 1890; Member, Oct. 1892

Elliott, Andrew, 27, Church Rord, Seaforth, near Liverpool ... (E) May 1903

Elliott, William D., Hessle, Hull ... ... (E) Nov. 1894

Eltringham, Harry, Messrs. J. T. Eltringham & Co., Stone Quay, South Shields ... ... (S) Feb. 1901

Eshelby, William, 13, Brankingham Terrace, Norton Road, Stockton-on-Tees ... ... (E) Feb. 1888

Evans, William, Superintendent Engineer, 8, Wordsworth Avenue, Cardiff ... ... (E) Nov. 1889

Eyres, Reginald J., 4, Cedars Crescent, Sunderland ... (C E) Feb. 1900

F.

Fairbairn, Archbold, F Violet Street, South Hylton, Sunderland (E) Mar. 1902

Fairbairn, James, 2, Creswick Road, Bow, London, E. (E) Graduate, May 1885; Member, April 1895

Fairburn, William Armstrong, P.O. Box, 273, New London, Conn. U.S.A. ... ... (N A) (E) Nov. 1902

Fairweather, C. W., c/o Messrs. Northern Counties Electricity Supply Co., Ltd., 13, Mosley Street, Newcastle-upon-Tyne (E) Oct. 1902

Farina, A. J., 63, Quayside, Newcastle-upon-Tyne ... ... (E) Nov. 1884

Farquharson, Geo. James, c/o Messrs. Elder, Dempster & Co., Luisenhof, Neue Gröninger Strass, 1, Hamburg ... ... (E) April 1899

Fenwick, James, B.Sc., C.E., 19, Bridge Street, Sydney, New South Wales ... ... (E) Oct. 1892

Ferguson, Wm. Deeble, 3, Mount Delphi, Antrim Road, Belfast ... (CE) Feb. 1901

Ferrier, Robert M., B.Sc., University College, Bristol ... ... (E) Nov. 1892

Ferry, S. O., 10, Malvern St., Newcastle-upon-Tyne ... ... (E) Oct. 1902

ELECTED.

Fettes, James, c/o Messrs. R. A. Mudie & Sons, Maritime Buildings, East, Dock Street, Dundee ... ... (E) May 1899
Field, Arthur M. C., 25, Mansfield Street, Thornaby-on-Tees ... (E E) Jan. 1898
Figari, Emanuel D., c/o Messrs. Barwick & Wright, 100, Bishopsgate Street, London, E.C. ... ... (S) Dec. 1900
Finch, Herbert K., Greyside, St. Edmund's Road, Ipswich ... ... (E) { Graduate, Dec. 1888 / Member, Nov. 1894
Findlay, John Taylor, Lloyds Register, Collingwood Buildings, Newcastle-upon-Tyne ... ... (S SUR) Mar. 1902
Fish, Thomas Wilson, Lloyd's Register of Shipping, 2 Hare Street, Calcutta, British India ... ...(SUR) May 1892
Fitzgerald, Arthur F., 1, Wood Terrace, South Shields ... ... (E) Oct. 1902
Fitzgerald, Durham W., Messrs. J. T. Eltringham & Co., Stone Quay, South Shields ... . (S) Dec. 1900
Fletcher. Robert, Walker Forge, Walker-on-Tyne ... ...(F M) Dec. 1886
Flohr, Justus, Director der Stettiner Maschinenbau-Actien-Gesellschaft "Vulcan," Rantstrasse 9, Stettin ... ... (E) Oct. 1886
Floyd, Joseph, jun., 18, Telford Street, Bensham, Gateshead (I & S M) Mar. 1903
Ford, John McLaren, 70, Mount Pleasant, Barrow-in-Furness ... (S) Nov. 1896
Forrest, Frank, 2, Bath Terrace, Tynemouth ... ...(E E) Nov. 1901
Foster, Henry, Greenhill, Sebastopol, near Newport, Mon. ... (E) April 1885
Foster, L. P., 113, Park Road, Newcastle-upon-Tyne (E) { Graduate, Nov. 1893 / Member, Oct. 1898
Foster, Martin, Claremont, Norton, Stockton-on-Tees ... ...(F M) Nov. 1900
Fothergill, J. R., 1, Bathgate Terrace, West Hartlepool ... ...(C E) Mar. 1886
Fowler, Jas. Speir, 27, Whitlets Road, Ayr, N.B. ... ... (E) Nov. 1901
Fownes, Henry, 6, Osborne Road, Jesmond, Newcastle-upon-Tyne (F M) Nov. 1884
Fox, Carter, 6, Denwick Terrace, Tynemouth ... (E) { Graduate, Feb. 1898 / Member, Dec. 1899
Fox, Samson, Grove House, Harrogate (*Life Member*) ... ... (E) Dec. 1887
Fox, William, 9, Winfield Terrace, Chester Road, Manchester ... (E) April 1895
France, Alfred Brown, Lingdale House, Westbourne Road, Middlesbrough ... ... (E) Feb. 1900
Franki, J. P., c o Messrs. Morts Dry Dock and Engineering Co., Sydney, N.S.W., Australia ... ... (E) Jan. 1886
Fraser, John Holt, c/o Messrs. A. & R. Brown & Co., 90, Regent Road, Liverpool ... ... (E) { Graduate, Oct. 1895 / Member, Jan. 1898
Fraser. Thomas S., 12, Edinburgh Road, Armley, Leeds ... ...(E E) Jan. 1894
Friederichs, Herbert F., 1, Stanhope Avenue, West Hartlepool (E E) Mar. 1901
Fuller, Philip S., 189, Cardigan Terrace, Gateshead-on-Tyne ... (E) Nov. 1899
Furneaux, J. B., Victoria Engine Works, Gateshead-on-Tyne ... (E) Nov. 1885

G.

Gaine, Roger L., Hartlepool Engine Works, Hartlepool (E) { Graduate, Dec. 1887 / Member, Oct. 1894
Gannaway, H. G., 7, Oxford Terrace, Renfrew, N.B. ... ... (S) Nov 1884
Garelli, Fabio, c/o Messrs. Odero fu Alessº, Sestri-Ponente, Italy (S) Oct. 1896
Garmey, John, Prince Line, Ltd., Produce Exchange, New York ... (E) Dec. 1898
Garson, Stanley T., 5, Rome Terrace, Borough Road, Middlesbrough ... ... (I M) Nov. 1902
Garthwaite, John R., c/o Messrs. R. Ropner & Sons, Stockton-on-Tees (S) May 1889

ELECTED.

Garwood, Harry Tom, Eng. Lieut. R.N., 36 Hawthorn Street, Newcastle-upon-Tyne... ... ... (R N E) May 1903

Gates, George, 57, Ancliffe, West Hartlepool ... ... (E) Jan. 1899

Gayner, Robt. H., Jun., West Bank, Sunderland ... (E) { Graduate, Mar. 1886 / Member, Oct. 1888

Gearing, Ernest George, Penshurst, Clarence Drive, Harrogate ... (E) Dec. 1892

Geddes, Christopher, 2A, Drury Lane, Water Street, Liverpool ... (E) Oct. 1888

Geddes, Frank, The Grove, Shotley Bridge, Co. Durham ... ... (E) Mar. 1902

Giacomuzzi, Virgilio, c/o Messrs. Nicolo Odero fu Alessandro, Sestri-Ponenti, Italy ... ... (N A) Nov. 1899

Gibson, H., 162, Roker Avenue, Monkwearmouth, Sunderland ... (S) Nov. 1884

Gibson, J. Hamilton, c/o Messrs. Laird Bros., Birkenhead Iron Works, Birkenhead ... ...(E) { Graduate, April 1891 / Member. Oct. 1894

Gibson, William Wight, 162, Roker Avenue, Sunderland ... (S) Nov. 1900

Gibson, W. H., 37, Tatham Street, Sunderland ... ... (E) Nov. 1884

Golledge, William, c/o Messrs. Aublet, Harry & Co., 53. Curtain Road, London, E.C. ... ... (E E) { Graduate, Nov. 1891 / Member, Nov. 1896

Good, Farrant, Beer, near Axminster, Devon ... ... (E) Mar. 1896

Gordon, William James, c/o Messrs. Vickers, Sons & Maxim, Naval Construction Works, Barrow-in-Furness ... ... (E) Oct. 1887

Gordon, William Leslie, Invermark, Broughty Ferry, N.B. ... (E) April 1893

Graham, James Thos., 126, Westmorland Road, Newcastle-upon-Tyne ... ... , (E) Nov. 1897

Graham, Joseph S., Morro House, Syon Street, Tynemouth ... (S) Feb. 1903

Graham, William, West House, Tynemouth ... ... (S) Oct. 1891

Graham, William, c/o Messrs. D. & W. Henderson & Co., Meadowside Works, Partick, Glasgow ... ... (S) April 1893

Graham, William, Rockcliffe, Redbrink Crescent, Barry Island, South Wales ... ... (E) Nov. 1894

Gravell, John, Bureau Veritas Register of Shipping, 155, Fenchurch Street, London, E.C. ... ... (N A SUR) Nov. 1884

Gray, A., 1, South Parade, Newcastle-upon-Tyne ... ... (E) Nov. 1888

Green, J. W., 3, Shaftesbury Place, Gateshead-on-Tyne ... (I & S M) May 1901

Green, W. G., Churchill Street, Willington Quay-on-Tyne ... (E) Nov. 1884

Griffith, Edwin, Messrs. The Wallsend Slipway and Engineering Co., Wallsend-on-Tyne ... ... (E) Nov. 1897

Grimes, Thomas Benjamin, 39, Vespasian Avenue, South Shields... (E) Mar. 1890

Gulston, A., Clayton Park Lodge, Jesmond, Newcastle-upon-Tyne (E) Dec. 1888

Gunn, Sir John, Chairman, Messrs. Mount Stuart Dry Docks Co., Cardiff (*Life Member*) ... ... June 1896

Gunter, John Henry, c/o Messrs. Dorman. Long & Co., Ltd., Britannia Steel Works, Middlesbro' ... ... (I & S M) Oct. 1902

H.

Hall-Brown, Ebenezer, St. Helens Engine Works, Govan, Glasgow (E) May 1902

Hall, Edward, 68, Grange Road West, Jarrow-on-Tyne ... ... (S) Nov. 1885

Hall, J. Percy, Carville, Lawrie Park Road, Sydenham, London, S.E. (E) Oct. 1885

Hall, John, 54, Westoe Parade, South Shields ... ... (E) May 1900

Hall, Thomas, 29, Selbourne Road, Ilford, London, E. ... ... (E) Nov. 1899

Hamilton, Andrew, 19, James Street, Liverpool ... ... (C E) April 1901

Hamilton, James, Beech House, Mile End, Stockport (E) { Graduate, Nov. 1897 / Member, Dec. 1901

ELECTED.

Hammar, Hugo G., Lindholmens, Verkstads Alstieholag, Göteberg, Sweden ... ... (S) Nov. 1890
Hammersley, B. J., c/o Messrs. Tyne Brass and Copper Tube Manufacturing Co., Jarrow-upon-Tyne ... . (E) May 1901
Hammond, Fleetwood C., c/o Messrs. Cowpen Coal Co., Ltd., Cowpen Colliery, Blyth ... ... (E) { Graduate, Nov. 1899 / Member, Dec. 1901
Haramüshi, M., Jun., Mitsubishi Dockyard and Engine Works, Nagasaki, Japan ... ... (N A) Nov. 1897
Harbottle, Thomas, 5, Alexandra Terrace, Newcastle-upon-Tyne (E) Jan. 1900
Hardy, Henry Thomas, 10, The Retreat, Sunderland ... ... (S) Dec. 1899
Harkness, Richard, Grange Road, West Hartlepool ... (S SUR) Nov. 1884
Harlow, F., 8, Benton Terrace, Newcastle-upon-Tyne ... .. (E) Nov. 1884
Harman, Bruce, Messrs. The Linde British Refrigerating Co., 35, Queen Victoria Street, London, E.C. ... ... (E) Oct. 1886
Harper, J. H., 1, Beaumont Street, North Shields ... ... (E) Jan. 1885
Harris, Anthony, 73, Queen Victoria Street, London, E.C. ... (E) Mar. 1892
Harris, John .. .. (E) Dec. 1902
Harrison, Alfred, c/o Messrs. Richardsons, Westgarth & Co., Scotia Engine Works, Sunderland (*Life Member*) ... (E) Oct. 1889
Harrold, Alexander, 26, Park Road, Newcastle-upon-Tyne ... (E) Nov. 1884
Harrold, F., 12, The Woodlands, Hexham ... ... (E) Nov. 1888
Harroway, George Mitchell, 18, West Terrace, North Ormesbey, Middlesbrough ... ... (S) Jan. 1896
Hartley, W. A., c/o Messrs. Charles Cammell & Co., Cyclops Works, Sheffield ... ... (E) Jan. 1898
Harvey, John W. J., 1, Richmond Villa, Chertsey Road, Redland, Bristol ... ... (E) Feb. 1889
Haswell, Wm. Spence, c/o Messrs. Tangye, Ltd., 3, St. Nicholas Buildings, Newcastle-upon-Tyne ... ... (E) Oct. 1900
Haussman, B., c/o Messrs. Borneo Co., Limited, 28, Fenchurch Street, London, E.C. ... ... (E) Feb. 1899
Hay, John, 7, Linden Mansion, Hornsey Lane, Crouch End, London, N.... ... ... (E) Nov. 1901
Hayashida, N., c/o Mitsubishi Dockyard & Engine Works, Nagasaki, Japan ... . (E) Oct. 1902
Hayhurst, James, 41, Warrington Road, Newcastle-upon-Tyne (C E) Nov. 1901
Head, William, Manager, Victoria Shipyard, Goole ... ... (S) Feb. 1901
Headlam, Robert, New Park Terrace, Hartburn Lane, Stockton-on-Tees ... ... (E) Nov. 1886
Heaviside, Arthur West, 7, Grafton Road, Whitley Bay, Northumberland ... ... (E E) Oct. 1896
Heck, John H., Lloyd's Register of Shipping, Collingwood Buildings, Newcastle-upon-Tyne ... ... (S SUR) Nov. 1885
Henderson, Alex., c/o Messrs. Empreza, Nacional, De. Nav. D'Vapor. Lisbon ... ... (E) April 1893
Henderson, A. M., 3, Greatham Terrace, West Hartlepool ... (E) Nov. 1890
Henderson, George, 54, Westmorland Road, Newcastle-upon-Tyne ... ... (E) Nov. 1884
Henderson, John, c/o Messrs. A. Henderson & Co., Mount Stewart Square, Cardiff ... ... (E) June 1896
Henderson, J. R., 3, Humbledon View, Sunderland ... ...(SUR) Oct. 1902

ELECTED.

Henry, William P., Cragside, St. Aidan's Road, South Shields ... (E) April 1897
Henshall, Samuel, c/o Messrs. Sir Raylton Dixon & Co., Middlesbrough ... ... (S) Graduate, May 1885; Member, Jan. 1894
Hepburn, Alfred, c/o Messrs. N.E. Marine Engineering Co., Northumberland Forge, Wallsend-on-Tyne ... ... (F M) Dec. 1890
Hepburn, James M., 17, Grosvenor Place, Newcastle-upon-Tyne ... ... (E) Graduate, Nov. 1895; Member, Dec. 1901
Hepple, W., Messrs. Hepple & Co., Wapping Street, South Shields ... ... (E & S) Oct. 1884
Hepple, W. T., Messrs. Hepple & Co., Wapping Street, South Shields ... ... (E) Dec. 1893
Hesketh, Thomas, Bryn Tirion, Richmond Road, Cardiff ... ...(SUR) April 1896
Heslop, Thomas, 6, Eldon Place, Newcastle-upon-Tyne ... ... (E) Dec. 1900
Hetherington, William, 2, Ewesley Road, Sunderland ... ... (S) Dec. 1899
Hewison, Herbert, 113, Woodbine Avenue, Wallsend-on-Tyne ... (S) Dec. 1900
Higginbotham, George Emerton, Glenthorn, Midhurst Road, Benton, Newcastle-upon-Tyne ... ... (E) Nov. 1900
Higgins, C. F., c/o Messrs. T. Richardsons, Westgarth & Co., Hartlepool Engine Works, Hartlepool... ... ... (E E) Feb. 1898
Hildrey, A. J., 11, Newcastle Road, Sunderland ... ... (S) Nov. 1884
Hill, Maxwell, 7, The Side, Newcastle-upon-Tyne ... ... (N A) Nov. 1884
Hills, Lawrence, 2, Somerset Terrace, East Bolden, Newcastle-upon-Tyne ... ... (S) Graduate, Nov. 1898; Member, Dec. 1901
Hinchliffe, Robert, 29, Lish Avenue, Whitley Bay, Northumberland ... ... (S) Graduate, Nov. 1893; Member, Oct. 1898
Hirst, Richard, 25, Brougham Terrace, West Hartlepool ... (E SUR) Nov. 1885
Hodge, Rowland F. W., c/o Messrs. The Northumberland Shipbuilding Co., Limited, Northumberland Shipyard, Howdon-on-Tyne ... ... (S) Dec. 1890
Hogarth, G. V., 32, Water Lane, Maryland Point, London, E.C. (S) May 1900
Hogg, Archibald, Welbeck Road, Walker-on-Tyne ... ... (S) Jan. 1897
Hogg, James, 8, Lovaine Terrace, North Shields ... ... (B F) Nov. 1889
Hogg, Thomas 8, Lovaine Terrace, North Shields ... ... (E) Feb. 1903
Hök, Wilhelm, 10, Karlaplan, Stockholm, Sweden ... ... (S) Oct. 1886
Holgate, Charles H., School Close Works, Leeds ... ... (E) Feb. 1895
Hollis, Henry E., 40 Union Street, Glasgow ... ... (I & S M) Feb. 1858
Holmes, John H., Wellburn, Jesmond Dene Road, Newcastle-upon-Tyne ... ... (E E) Jan. 1888
Hougland, Even, Lloyd's Surveyor, Bergen, Norway ... ... (E) Dec. 1896
Houston, John, 7 Thornhill Crescent, Sunderland ... ... (E) Nov. 1894
Hughes, Thos. Charles, 3, Summerhill Street, Newcastle-upon-Tyne ... ... (E) Graduate, Nov. 1893; Member, Nov. 1897
Humphreys, George, 24, Mayfield Road, Gosforth, Newcastle-upon-Tyne ... ... (E) Jan. 1902
Hunt, Allen E., 11, St. Cuthbert's Terrace, Bensham, Gateshead (SUR) Feb. 1901
Hunter, George B., Messrs. Swan, Hunter & Wigham Richardson, Ltd., Wallsend-on-Tyne ... ... (S) Nov. 1884
Hunter, George Ernest, Aykleyheads, Durham ... (S) Graduate, Feb. 1898; Member, Nov. 1899
Hunter, Joseph Gilbert, Lloyds Register of Shipping, P.O. Box No. 671, Newport News, Va., U.S.A. ... ... (SUR) Feb. 1900

ELECTED.

Hunter, J. W., 22, Argyle Square, Sunderland ... ... (E) May 1885
Hunter, Summers, c/o Messrs. N.E. Marine Engineering Co., Northumberland Engine Works, Wallsend-on-Tyne ... ... (E) Nov. 1885
Hutchinson, C. W., 6, Park Parade, Westmoreland Road, Newcastle-on-Tyne ... ... (E) Nov. 1884
Hutchison, J., Board of Trade Offices, Middlesbrough ... ...(SUR) Dec. 1891
Hutchinson, Wesley, B.A. ... ... (E) Oct. 1891
Hyslop, Alfred M., c/o Messrs. Boothroyd, Hyslop & Co., Akenside Street, Bootle, Liverpool ... ... (E) Mar. 1900

I.

Inglis, John, c/o Messrs. Hawthorn & Co., Leith ... ... (S) April 1887
Inglis, John, LL.D., Pointhouse Shipyard, Partick, Glasgow (E & S) Oct. 1886
Ions, Thos. R., 11, Newcastle Street, North Shields ... ... (E) May 1903
Irvin, Matthew B., Ibrahimich, Ramleh, Egypt ... ... (E) Oct. 1900
Irwin, J. H., Mowbray Terrace, Sunderland ... ... (E) Nov. 1884
Ito, Kumezo, Mitsu Bishi Dockyard and Engine Works, Nagasaki, Japan ... ... (E) Dec. 1900

J.

Jack, Fred Barrie, Messrs. Worthington Pumping Engine Co., 32, Grainger Street, West, Newcastle-upon-Tyne ... ... (E) Nov. 1901
Jack, William C., c/o Messrs. The Hong Kong & Whampoa Dock Co., Limited, Hong Kong, China ... ... (E) Nov. 1894
Jackson, William S., Messrs. Gourlay Bros. & Co., Camperdown Shipyard, Dundee... ... ... (S) April 1891
James, M. C., 6, Park Terrace, Gateshead-on-Tyne ... ... (S) Nov. 1884
Jarvis, Harry Robert, 14, Burnfoot Terrace, Whitley Bay, Northumberland ... ... (S) Feb. 1901
Jarvis, Horace William, West Dyke, Coatham, Redcar ... ... (E) May 1902
Jobling, W. J., 7, The Side, Newcastle-upon-Tyne ... ... (E & S O) Nov. 1884
Jobson, Robert, Jun., Rhenass, Clifton Avenue, West Hartlepool (S) Feb. 1898
Johnson, Alexander A., Bank Chambers, Sandhill, Newcastle-upon-Tyne ... ... (E) Feb. 1893
Johnson, Johan, 7, Vestra Hamngaten, Gothenburg, Sweden ... (S) May 1885
Johnson, Joseph, Bentham Buildings, Side, Newcastle-upon-Tyne (E) May 1901
Johnson, T. Allan, 64, Cathedral Road, Cardiff ... ... (S) Nov. 1884
Johnstone, William, Lloyd's Register of Shipping, 14, Cross-shore Street, Greenock ... ...(SUR) Nov. 1884
Jones, Arthur P., Messrs. Hungarian Levant S.S. Co., Ltd., Constantinople ... ... (E) April 190.
Jones, George, c/o Messrs. W. Gray & Co., Shipyard, West Hartlepool ... ... (S) Oct. 1888
Jubb, Arthur, 69, Lonsdale Street, Bradford ... ... (E) Jan. 1900

K.

Kapadia, Framjee Dorabjee, c/o Messrs. The Ahmedabad Ginning & Manufacturing Co., Ahmedabad, British India ... ... (E) Feb. 1903
Keene, H. R., Lloyd's Register of Shipping, Ouest Quai, 28, Katendyk, Antwerp ... ... (E) { Graduate, May 1885 / Member, April 1887
Kelly, A. Wardle, 94, Kingsley Terrace, Newcastle-upon-Tyne ... (E) Oct. 1902

ELECTED.

Kendall, Stonard O., Lloyd's Register of Shipping, Ramsden Square, Barrow-in-Furness ... ...(SUR) Mar. 1891
Kennedy, William, 14, Gladstone Street, Hartlepool ... ... (E) April 1900
Kerfoot, James, Rue Osy, 20, Antwerp ... ... (E) Oct. 1892
Kerr, Robert, Bank Chambers, Mosley Street, Newcastle-upon-Tyne ... ... (E) Oct. 1902
King, John, Surveyor's Office, Board of Trade, Liverpool ... ... (S) { Graduate, Dec. 1890 / Member, Oct. 1892
Kirby, John Storm, 4, Westoe Terrace, South Shields ... ... (E) Mar. 1899
Kirkaldy, John, 21, Ground Floor, Leadenhall House, 101, Leadenhall Street, London, E.C. ... ... (E) Nov. 1885
Kitching, J. F., 134, Fenchurch Street, London, E.C. ... ... (E) Nov. 1890
Kyle, Norman M. W., Norwood, West Avenue, Gosforth, Newcastle-upon-Tyne ... ... (E) Nov. 1898

L.

Lace, Basil T., Llanbedr Hall, near Ruthin, N. Wales (E) { Graduate, Nov. 1895 / Member, Nov. 1897
Laidler, William, Messrs. The Upper Tyne Engineering Co., Skinnerburn Road, Elswick, Newcastle-upon-Tyne ... ... (E) Nov. 1901
Laing, Andrew, c/o Messrs. Wallsend Slipway and Engineering Co., Wallsend-on-Tyne ... ... (E) Oct. 1892
Laing, Hugh, Deptford Shipyard, Sunderland ... ... (N A) April 1897
Laing, John, 5, Tynemouth Road, Heaton, Newcastle-upon-Tyne (E) Nov. 1884
Landreth, Cowen, 34, Simonside Terrace, Newcastle-upon-Tyne ... (E) Mar. 1896
Larkin, James, Tyne View, East Jarrow-on-Tyne ... ... (E) Nov. 1884
Latta, James G., 78, Billiter Buildings, Billiter Street, London, E.C. (C E) Mar. 1902
Le Rossignol, Alfred Ernest, 8, Victoria Square, Newcastle-upon-Tyne ... ... (E E) Nov. 1902
Leach, Thos. A. Wm., 14, Rue de Bastion, Antwerp ... ... (E) May 1903
Leathard, Thomas Surtees, 9, Otto Terrace, Sunderland ... ...(SUR) April 1899
Lee, Hugh Warren, 88, Manor House Road, Jesmond, Newcastle-upon-Tyne ... ... (E) { Graduate, Dec. 1899 / Member, Jan. 1902
Lees, Charles, Loanda, Shirehampton, near Bristol ... ... (E) Oct. 1902
Lewins, Frank, Rosehill, Willington-on-Tyne ... ... (E) Dec. 1895
Lewis, R. A., Newburn Steel Works, Newburn-on-Tyne ... ... (E) Nov. 1884
Liddell, J., c/o Messrs. W. Denny & Co., Engine Works, Dumbarton (E) Nov. 1884
Lie, Gotfred, Det Bergenske Dampskibsselskab, Bergen ... ... (E) Jan. 1895
Lindberg, George, Studsgarden 8, Stockholm ... ... (N A & C E) Nov. 1901
Lindfors, Hugo, Surveyor to Lloyd's Register of Shipping, 16 Alexandersgatan, Helsingfors, Finland ... ... (SUR) May 1889
Lineham, Wilfrid J., Jesmond, 21, Newstead Road, Lee, London, S.E. ... ... (E) Oct. 1890
Link, Rolls Percival, 126, Pilgrim Street, Newcastle-upon-Tyne ... (C E) Mar. 1901
Lishman, John J., Jun., 16, Lovaine Place, North Shields ... ... (E) { Graduate, Dec. 1892 / Member, May 1900
Little, Frank, 31, Westgate Road, Newcastle-upon-Tyne ... ... (E E) April 1902
Littleboy, Chas. Wm., The Woodlands, Saltburn-by-the-Sea ... (S) Oct. 1887
Littledale, John W. E., c/o Messrs. Charing Cross & City Electricity Co., Cannon Street Sub-station, All Hallows Lane, London, W.C. ... ... (E) May 1896
Livingston, Thos. L., Dunedin House, Jarrow-on-Tyne ... ... (S) Nov. 1884
Lohmeyr, H. G. C., 53, Crown Street, Newcastle-upon-Tyne ... (E) Nov. 1884

ELECTED

London, William Jas. Albert, c/o Messrs. Westinghouse Electric & Manufacturing Co., Steam Tube Department, Trafford Park, Manchester ... ... — Graduate, May 1898; Member, May 1901

Long, A. E., 124, Albert Road, Jarrow-on-Tyne ... ... (S) Nov. 1884

Loveridge, Wm. Henry, York Road, West Hartlepool ... ... (E) Feb. 1901

Lowdon, John, Messrs. The Barry Graving Dock and Engineering Co., Limited, Barry Dock, near Cardiff ... ... (E) Dec. 1891

Lumley, Gascoigne, 4, Claremont Place, Gateshead-on-Tyne ... (E) Nov. 1901

Lund, Pearson, Messrs. Noble & Lund, Northern Machine Tool Works, Felling-on-Tyne ... ... (E) Nov. 1900

M.

MacColl, Hector, Kirkliston Drive, Bloomfield, Belfast ... ... (E) Dec. 1890

MacColl, Hugo, Wreath Quay Engineering Works, Sunderland (*Life Member*) ... ... (E) Nov. 1896

Maccoy, John, Springfield, Gateshead-on-Tyne ... ... (E) Feb. 1886

Macdonald, Charles, 4, St. Nicholas' Buildings, Newcastle-upon-Tyne ... ...(SUR) Feb. 1898

MacDonald, David R., c/o Messrs. Sir W. G. Armstrong, Whitworth & Co., Ltd., Walker Shipyard, Newcastle-upon-Tyne (S) Nov. 1891

Macdonald, John C., c/o Messrs. Workman, Clark & Co., Ltd., Engine Department, Belfast ... ... (E) Nov. 1899

MacDonald, John, 9, York Street, Glasgow ... ... (E) Dec. 1900

Mace, W., 253, Albert Road, Jarrow-on-Tyne ... ... (E) Jan. 1886

Macfarlane, Archibald P., 15, Beacon Street, Low Fell, Gateshead-upon-Tyne ... ... (E) Mar. 1902

Macgregor, W. L., Board of Trade Surveyors' Offices, Blyth ...(SUR) Mar. 1899

MacHaffie, John, 635, Terrace Place, Schenectady, New York, U.S.A. (E) Dec. 1885

Mackay, William, 15, Camperdown Road, Scotstoun, Renfrewshire ... ... (S) Mar. 1892

Mackley, Edward N., 97, Enfield Road, Elswick, Newcastle-upon-Tyne... ... ... (E) April 1901

MacMillan, H. M., B.Sc., 58, Fern Avenue, Jesmond, Newcastle-upon-Tyne ... ... (S) Jan. 1902

Mail, M., Jun., c/o Messrs. Middle Dock and Engineering Co., South Shields ... ... (E) Nov. 1897

Male, Francis John, 4, Normanby Terrace, Gateshead-on-Tyne ... (E) Nov. 1902

Manaira, Guiseppe, c/o Messrs. The Cantiere Navale di Muggiano, Spezia, Italy ... ... (E & N A) Nov. 1893

Manning, Henry Lewis, E. Lieut., R.N., H.M.S. "Pioneer," Mediterranean Station ... ... (R N E) Dec. 1900

Marr, James, c/o Messrs. J. L. Thompson & Sons, North Sands Shipyard, Sunderland ... ... (S) Nov. 1884

Marshall, Frank T., Messrs. R. & W. Hawthorn, Leslie & Co., St. Peter's, Newcastle-upon-Tyne ... ... (E) — Graduate, Jan. 1885; Member, Oct. 1888

Marshall, R. J., 53, Larkspur Terrace, Jesmond, Newcastle-upon-Tyne... ... ... (E) Mar. 1887

Marshall, Robert, 12, Broughton Road, South Shields ... ...(SUR) Mar. 1901

Martin, William, 69, Hotspur Street, Heaton, Newcastle-upon-Tyne (E) Oct. 1902

Maslen, Frank E., The Priory, Hampstead Heath, London, N.W. ... ... (E) — Graduate, Nov. 1891; Member, May 1898

ELECTED.

Mason, George F., Lloyds' Bank Buildings, Mount Stuart Square, Cardiff ... ... (E) Oct. 1895
Mather, Charles, 60, St. George's Terrace, Newcastle-upon-Tyne (SUR) Oct. 1888
Mather, Clifford Basil, Lesbury House, Lesbury, R.S.O. (NA) { Graduate, Oct. 1892 / Member, Oct. 1898
Mather, Thomas Brewer, 13, Park Avenue, Whitley Bay, Northumberland ... ... (CE) Nov. 1898
Matheson, William, c/o Messrs. R. & W. Hawthorn, Leslie & Co., Hebburn-on-Tyne... ... ... (S) Dec. 1889
Mathieson, Donald, 30, Jackson Street, Sunderland ... ... (E) Nov. 1898
Matthews, A., Laureldyne, Midhope Road, Woking, Surrey ... (S) Nov. 1884
Matthews, Jas., c/o Messrs. R. & W. Hawthorn, Leslie & Co., Forth Banks, Newcastle-upon-Tyne ... ... (E) Oct. 1886
Maughan, Philip A., 8, Ashleigh Grove, West Jesmond, Newcastle-upon-Tyne ... ... (S) Dec. 1900
Maxwell, Thomas, 15, Ashfield Terrace, East, Newcastle-upon-Tyne ... ... (E) Nov. 1899
Maxwell, William Ward, B.Sc., Messrs. H. Charlton & Co., Engineers, Gateshead-on-Tyne ... ... (E) Dec. 1896
McBride, William, Hartburn, Cleveland Road, Hartlepool ... (E) Dec. 1894
McCoull, Cecil, 7, Lewisham Road, Highgate Road, London, N.W. .. .. (EE) { Graduate, Oct. 1895 / Member, Dec. 1901
McGillivray, Peter, 14, Normanton Terrace, Newcastle-upon-Tyne (E) Nov. 1899
McGlashan, Arch., Beechcroft, Clifton Avenue, West Hartlepool (S) Nov. 1885
McGregor, Duncan, 31, Argyle Street, Hebburn ... . (S) Dec. 1899
McIlvenna, J. G., c/o Messrs. The Tyne Pontoons and Dry Docks Co., Wallsend-on-Tyne ... ... (S) Nov. 1884
McKechnie, James, Messrs. Vickers, Sons & Maxim, Naval Construction Works, Barrow-in-Furness ... ... (E) April 1896
McKenna, Francis, c/o Messrs. E. F. Wailes & Co., 4, St. Nicholas' Buildings, Newcastle-upon-Tyne ... (E) { Graduate, Dec. 1890 / Member, Dec. 1896
McLaren, Robert M., Lloyd's Register of Shipping, 321, The Bourse, Philadelphia, U.S.A. ... ... (S) Nov. 1893
McLaren, William, 16, Rock Park, Rock Ferry, Cheshire ... ... (E) Oct. 1894
McLean, John H. K., Abey House, Plotina Terrace, South Shields (S) Mar. 1897
McLellan. William, Collingwood Buildings, Newcastle-upon-Tyne (CE) Feb. 1903
McNab, Andrew P. W., Lloyd's Registry of Shipping, Collingwood Buildings, Newcastle-upon-Tyne ... ... (SUR) May 1903
McNeil, Thomas Young, Ship Drawing Office, Messrs. John Brown & Co., Clydebank, Glasgow ... ... (S) Oct. 1895
McRae, Thomas, 16, Western Hill, Sunderland ... ... (S) Dec. 1900
Meagher, H. L., 4, Linden Terrace, Newcastle-upon-Tyne ... ... (E) Dec. 1896
Mechan, Henry, Scotstoun Ironworks, Scotstoun, Glasgow ... (E) May 1898
Meldrum, Michael, Humbledon View, Sunderland ... ... (E) Dec. 1893
Mellanby, Alex. Lawson, B.Sc., 33, Keppel Road, Chorlton-cum-Hardy, Manchester ... ... (E) { Graduate, Dec. 1894 / Member, Oct. 1896
Melville, James, Duke Street, Barrow-in-Furness ... (E) { Graduate, Feb. 1900 / Member, Jan. 1902
Merz, Charles H., Collingwood Buildings, Newcastle-upon-Tyne... (CE) Feb. 1903
Messenger, Thomas, "Greeba," Matham Road, East Molesey, Surrey ... ... (E) Mar. 1887

ELECTED.

Metcalf, Thos., 18, John Street, Sunderland... ... (S) { Graduate, May 1885 / Member, Nov. 1893

Metcalfe, C. S.. 24, Croft Avenue, Sunderland ... ... (E) Nov. 1884

Meuwissen, J., 18, Esplanade, Whitley Bay, Northumberland ... (E) Nov. 1899

Micheli, Pietro, Jun., Via Sottoripu, No. 1, piano nobile, Genoa, Italy ... ... (E & N A) Oct. 1888

Middlemass, Thomas, 3, Albert Place, Norton Road, Stockton-on-Tees... ... ... (S) Oct. 1889

Middleton, H., 20, Lynnwood Avenue, Newcastle-upon-Tyne (I & S M) Jan. 1893

Middleton, Robert Alexander, 20, The Grove, Benton, near Newcastle-upon-Tyne ... ... (N A) Oct. 1892

Millar, Thos., c/o Messrs. Sir W. G. Armstrong, Whitworth & Co., Ltd., Walker Shipyard, Walker-on-Tyne ... ... (S) Nov. 1884

Milton, James Edward, Messrs. Lloyd's Register of Shipping, 71, Fenchurch Street, London, E.C. ... ...(SUR) Nov. 1900

Milton, J. T., Lloyd's Register of Shipping, 71, Fenchurch Street, London, E.C. ... ... (E SUR) Nov. 1886

Mitchell, Wm., Glen Street, Hebburn-on-Tyne ... (S) { Graduate, Jan. 1898 / Member, Feb. 1901

Moffatt, James, 7, Murray's Terrace, Belfast, Ireland (E) { Graduate, Dec. 1889 / Member, Oct. 1892

Moffatt, William Graham, 44, Lennox Avenue, Scotstoun, Glasgow (E) Mar. 1899

Moffitt, George, c/o Messrs. The Blyth Shipbuilding Co., Blyth ... (S) Oct. 1888

Moffoot, Alexander, 32, Eldon Street, Chester Road, Sunderland.. (S) Mar. 1898

Moncrieff, John M., 1, St. Nicholas' Buildings, Newcastle-upon-Tyne .. .. (C E) Dec. 1899

Moody, Thomas V., c/o Messrs. Scott Bros., 46, Sandhill, Newcastle-upon-Tyne ... ... (E) Dec. 1887

Moore, Wm. Henry, c/o Messrs. Workman, Clark, & Co., Engine Works, Spencer Basin, Belfast ... ... (E) Nov. 1897

Morgan, John Osborn, Bank Chambers, Sandhill, Newcastle-upon-Tyne... ... ... (CE) Feb. 1901

Morgan, W. H., 22, Rochdale Street, Wallsend-on-Tyne ... ... (E) Nov. 1884

Morgan, William George, 10, Rue du Bastion, Antwerp ... ... (S) May 1903

Morison, D. B., Hartlepool Engine Works, Hartlepool ... ... (E) Feb. 1885

Mörk, Peter, 31, Holsteinsgude, Copenhagen ... ... (E) Nov. 1884

Moroney, E. F., 115, Warton Terrace, Heaton, Newcastle-upon-Tyne ... ... (E) { Graduate, Feb. 1892 / Member, Nov. 1899

Morrison, Robt., Castle View, Kirkby Stephen, Westmoreland ... (E) Nov. 1886

Morrison, William, Lloyd's Register of Shipping, Maritime Buildings, Dundee ... ... (E SUR) Oct. 1890

Morton, John, 18, St. George's Square, Sunderland... ... ... (E) Nov. 1902

Morton, Richard Fraser, Lloyd's Register of Shipping, 24, George Street, Sheffield ... ... (E SUR) Oct. 1890

Moss, William, Kirkview. Shipley, Yorkshire ... (E) { Graduate, Jan. 1898 / Member, Dec. 1901

Mould, Francis H., 37, Hawthorn Road, Gosforth, Newcastle-upon-Tyne ... ... (E) { Graduate, Feb. 1892 / Member, Jan. 1897

Mountain, William Chas., Messrs. Ernest Scott, Mountain, & Co.. Close, Newcastle-upon-Tyne ... ... (E E) Feb. 1889

Mudd, Percival Arthur, Greencliffe, Hartlepool ... ... (E) Oct. 1902

ELECTED.

Mudie, James Herbert, 14, Jesmond Road, Newcastle-upon-Tyne (E) Dec. 1902

Muir, Alfred Edward, Messrs. J. L. Thompson & Sons, North Sands Shipyard, Sunderland ... ... (S) Mar. 1893

Muir, Robert, 11, Clarence Crescent, Whitley Bay, Northumberland ... ...(SUR) Oct. 1886

Muir, Robert Home, 1, Lovaine Crescent, Newcastle-upon-Tyne ... (S) Oct. 1892

Munck, Ove. Holger, c/o Messrs. Burmeister & Wain, Shipbuilders, Copenhagen, Denmark ... ... (S) Feb. 1899

Murray, Charles W., c/o Messrs. Babcock & Wilcox, Ltd., Ogle House, Farringdon Street, London, E.C. ... ... (E) May 1901

Murray, Councillor W., 30, Simonside Terrace, Newcastle-upon-Tyne ... ... (E) Oct. 1902

Musgrave, Evers, 8, Lastingham Terrace, Frilford, York (E) { Graduate, Nov. 1891 / Member, Oct. 1895

Myles, David, c/o Messrs. N.E. Marine Engineering Co., Northumberland Engine Works, Wallsend-on-Tyne ... ... (E) Nov. 1884

N.

Nastoupil, John, Chief Engineer, Austro-Hungarian Navy, Marine Casino, Pola, Austria ... ... (E) Nov. 1890

Neill, William Reid, 15, Salem Hill South, Sunderland ... ... (E) Dec. 1897

Nelson, George, c/o Messrs. Blyth Foundry and Engineering Co., Blyth ... ... (E) { Graduate, Jan. 1900 / Member, Dec. 1901

Nevins, William, Hazel Rrae, Bradford Road, Shipley, Yorkshire (E) Mar. 1894

Nevison, Thomas C., 18 Milton Road, West Hartlepool ... ... (E) April 1900

Nicholls, H. E., 25, Churchill Street, Sunderland ... ... (E) Nov. 1893

Nichols, Walter W., 4 South View, London Road, Peterborough ... (E) May 1895

Nicholson, John S., North View, Mowbray Road, Westoe, South Shields ... ... (E) Nov. 1893

Nicholson, P. F., c/o Messrs. R. & W. Hawthorn, Leslie, & Co., Hebburn-on-Tyne ... ... (S) Feb. 1901

Nicholson, Thos. Head, 90, Rye Hill, Newcastle-upon-Tyne ... (E) Nov. 1897

Nicol, John M., 15, Linskill Terrace, North Shields ... ... (E) Nov. 1884

Nicolson, G. C., H.M.S. "Stag," Malta ... ... (E) { Graduate, Oct. 1885 / Member, Oct. 1888

Niven, William A., 6, Jackson Street, Walker-on-Tyne ... ... (E) Nov. 1898

Nixon, John R, c/o Messrs. Blyth Shipbuilding Co., Ltd., Blyth... (S) Oct. 1902

Noble, Harry, Northern Machine Tool Works, Brewery Lane, Felling-on-Tyne .. .. (E) Nov. 1888

Nodder, Joseph, 350, Fulwell Road, Sheffield ... ...(F M) May 1893

Norman, W. S., White House, Whitby, near Chester ... ... (E) Nov. 1884

Norton, Harold P., U.S.S. "Albany," c/o Senr. Squadron Commander, U.S. Naval Forces, Cavite, P.I. ... ... (E) Oct. 1890

Noton, F. R., Lloyd's Register of Shipping, 342, Argyle Street, Glasgow ... ... (S) Nov. 1884

Nunes, Enrique E., 1898 Calle Virreyes, Belgrano, Buenos Ayres (E) April 1891

O.

Oliver, John Wm., 31, Baring Street, South Shields ... ... (E) Dec. 1900

Olsen, Hans B., jun., Victoria Road, West Hartlepool (E) { Graduate, Feb. 1895 / Member, Feb. 1902

O'Neil, J. J., 2, Erith Terrace, Sunderland ... . (E) Nov. 1884

ELECTED.

Ord, Godfrey C., 4, The Esplanade, Sunderland ... ...(E E) Jan. 1897
Orde, E. L., c/o Messrs. Sir W. G. Armstrong, Whitworth & Co., Ltd., Walker Shipyard, Newcastle-upon-Tyne ... ... (E) Oct. 1887
Orlando, Chev. Giuseppe, Cantiere Navale, Fratelli Orlando, Leghorn ... ...(N A) Jan. 1893
Ormonde, John Grey, 35, Percy Gardens, Tynemouth ... ... (E) Nov. 1897
Orr, John, Prof., B.Sc., Kimberley Club, Kimberley, South Africa (E) Mar. 1897
Ortton, Alfred R., 27, General Graham Street, Chester Road, Sunderland ... ... (E) Nov. 1898
Ostens, Joseph, 4, Jackson Street, North Shields ... . (S) Nov. 1900
Oxley, Alfred, 13, Beaconsfield Avenue, Low Fell, Gateshead ... (C E) Oct. 1902
Oxley, G., 51, Norman Terrace, Howdon-on-Tyne ... ... (S) Nov. 1884
Oxton, Walter, 5, Beech Lane, Stretton, near Burton-on-Trent ... ... (E) { Graduate, Dec. 1890 / Member, May 1894

P.

Paget, John W. ... ... (S) Dec. 1900
Parker, James H., 11, Gladstone Street, Hartlepool ... ... (E) April 1900
Parsons, Harry F., Lindenhurst, Clarence Road, Teddington, Middlesex ... ... (E) Dec. 1890
Parsons, Hon. Charles A., Turbinia Works, Wallsend-on-Tyne ... (E E) Dec. 1887
Pascoe, J. R., Tyrmont, Woodford Green, Essex (*Life Member*) ... (S) Dec. 1889
Patterson, Jas., c/o Messrs. Caldwell & Co., Limited, Elliot Street, Glasgow ... ... (E) Nov. 1884
Patterson, Robert O., Thorneyholme House, Blaydon-on-Tyne ... ... (E) { Graduate, Jan. 1895 / Member, Dec, 1901
Patterson, Thomas Henry, 2, The Elms, Sunderland .. ... (S) Jan. 1902
Pattison, Jos., Bute Docks, Cardiff ... ... (E) Nov. 1884
Paulin, William J., 24, Oxford Street, Newcastle-upon-Tyne ... (E) April 1897
Paxton, John F., 52, Walker Terrace North, Gateshead ... ... (E) May, 1899
Pearson, James T., 26, Lish Avenue, Whitley Bay (S) { Graduate, Nov. 1893 / Member, Dec. 1897
Peat, Herbert, 9½, Russell Street, Stockton-on-Tees ... ... (E) Mar. 1902
Penney, R. H., Board of Trade Offices, 79, Mark Lane, London, E.C. ... ... (S SUR) Nov. 1884
Pepper, W., 9, West Villas, Oxbridge Lane, Stockton-on-Tees ... (E) Nov. 1888
Perrett, Jos. Richard, c/o Messrs. Sir W. S. Armstrong, Whitworth & Co., Elswick Shipyard, Newcastle-upon-Tyne ... ... (N A) Nov. 1896
Pescod, Joseph Hind, 1, Railway Street, Jarrow-on-Tyne (S) { Graduate, Feb. 1898 / Member, Jan. 1900
Petree, James, Lloyd's Register of Shipping, 12, Oriel Chambers, Water Street, Liverpool ... ... (N A SUR) Oct. 1885
Petterson, Carl Edwin, 7, Vestra Hamngaten, Gothenburg, Sweden (E) Oct. 1891
Phayer, Robert P., 27, Edwards Road, Whitley Bay, Northumberland ... ... (S) Dec. 1900
Phillips, Joseph, 15, Park Avenue, Wallsend-on-Tyne ... ... (S) Dec. 1902
Philipson, Roland, Tynemouth... ... ... (E) Dec. 1884
Phorson, P., Glen Lea, Roker, Sunderland ... ... (S) Nov. 1884
Piaud, Leon, c/o Messrs. Delanney, Bellville, & Co., St. Denis, France ... ... (N A) Nov. 1888

ELECTED.

Pierce, Robert Cecil, 14, West Park Gardens, Kew, Surrey ... ... (E E) { Graduate Dec. 1898 / Member Dec. 1899

Pitt, Frederick William, 552. Chester Road, Old Trafford, Manchester, S.W. ... ... (E SUR) Oct. 1890

Poli, Rodolfo, Chioggia, Italy ... ... (N A) Jan. 1890

Pollock, Walter, c/o Messrs. Jas. Pollock, Sons, & Co., 3, Lloyds Avenue, London, E.C. ... ... (N A) April 1900

Posgate, James S., Durham House, Windmill Street, Gravesend, Kent ... ... (E) { Graduate, Nov. 1895 / Member, Dec. 1901

Potts, Cuthbert Ivan, 4, Sidney Road, Bootle, Liverpool .. ... (E) Oct. 1895

Potts, Herbert Joseph, 42, Grosvenor Place, Jesmond, Newcastle-upon-Tyne ... ... (E) Nov. 1902

Powell, James Richard, Royal Stuart Buildings, Cardiff ... ... (C E) May 1894

Pringle, Alfred, 10, Somerset Terrace, Walker-on-Tyne (S) { Graduate, Dec. 1891 / Member, Jan. 1894

Pringle, James G., 10, Somerset Terrace, Walker-on-Tyne... ... (S) Oct. 1892

Proven, George, 358, Leith Walk, Leith, N.B. ... ... (E) Mar. 1901

Purdon, Andrew S., Messrs. Irvine's Shipbuilding and Dry Docks Co., Limited, West Hartlepool ... ... (S) Oct. 1892

Purvis, Andrew Alex., 17, Brook Terrace, Whitley Bay, Northumberland ... ... (E) Dec. 1899

Purvis, Fred. W., c/o Messrs. Sir W. Gray & Co., Central Shipyard, West Hartlepool ... ... (S) April 1893

Putnam, T., Darlington Forge, Darlington ... ... (FM) Nov. 1884

Q.

Quicke, Herbert John, c/o Messrs. Harfield & Co., Blaydon Ironworks, Blaydon-on-Tyne ... ... (E) Feb. 1891

R.

Ramage, J. T., St. Aubyn's, Bonnington, Edinburgh ... ... (E) April 1887

Ramage, John Anderson, 72, Glen Terrace, Hebburn-on-Tyne ... (S) Oct. 1892

Ranken, David, 8, Brookside Terrace, Sunderland ... ... (E) Nov. 1900

Rappaport, Fred. G., Messrs. Russian Petroleum and Liquid Fuel Co., Baku, South Russia ... ... (E) { Graduate, Mar. 1894 / Member, Jan. 1902

Readhead, Jas., Westoe Hall, South Shields ... ... (S) Nov. 1884

Readhead, John, Rockcliffe, Westoe, South Shields ... ... (E) Mar. 1886

Readhead, R., South Garth, Westoe Village, South Shields ... (E) Nov. 1884

Readhead, W. B., Beach View, South Shields .. .. (S) Nov. 1886

Redpath, David, 59, Claremont Road, Seaforth, Liverpool ... (E) Nov. 1901

Reed, Joseph, Angerton House, North Shields ... ... (E) Oct. 1889

Reed, J. W., c/o Messrs. Palmer's Shipbuilding and Iron Co., Limited, Engine Works Department, Jarrow-on-Tyne ... (E) Nov. 1884

Reed, Richard, 99, Clarence Drive, Partick Hill, Glasgow ... (S) Oct. 1894

Reid, John Robert, 8 Richmond Road, Ipswich ... ... (E) Nov. 1898

Reid, William, c/o Messrs. Wm. Reid & Co., 112, Fenchurch Street, London, E.C. ... ... (E) Dec. 1899

Reilly, Myles O'Hara, 13, Woodlands Terrace, Borough Road, Middlesbrough ... ... (S) Oct. 1902

Rennoldson, C., Messrs. J. P. Rennoldson & Sons, South Shields (S) Jan. 1886

ELECTED.

Rennoldson, Jos. M., Fairfield, Westoe, South Shields ... ... (S) Feb. 1886
Reynolds, Charles H., c/o Messrs. Burmeister & Wain, Shipbuilders, Copenhagen, Denmark ... ... (S) Mar. 1889
Reynolds, W. G. ... ... (E) Oct. 1886
Rhodes, Joseph Henry, Stonyroyd, Oxbridge Lane, Stockton-on-Tees ... ... (E) Nov. 1901
Richardson, John Lyth, Deddington Chambers, Hull ... ... (E) Nov. 1901
Richardson, Sir Thomas, B.A., Hartlepool Engine Works, Hartlepool ... ... (E) April 1888
Richardson, Wigham, Hinley Hall, Stocksfield, Northumberland (E & S) Nov. 1884
Rickaby, A. A., 27, Olive Street, Sunderland ... ... (E) Mar. 1888
Ridley, J. H., Park End, Wark-on-Tyne ... ... (E) Nov. 1884
Riley, J. H., Messrs. Riley Bros., Stockton-on-Tees ... ... (B B) May 1893
Riley, John, 1, Spring Street, Stockton-on-Tees ... ... (B M) Oct. 1902
Riseley, Harry Lorimer, Western Villa, Wallsend-on-Tyne ... (E) Nov. 1900
Ritson, Maurice, Lloyd's Register of Shipping, Piazza S. Giorgio, 32, Genoa ... ... (E SUR) Nov. 1884
Ritson, S. M., 7, Dogo Street, Cardiff ... ... (E { Graduate, Nov. 1887 / Member, Nov. 1893
Roberts, W. C., 18, Windsor Road, Forest Gate, Essex ... ... (E) Mar. 1901
Robinson, Charles O., Ingleside, North Shields ... (E) { Graduate, Dec. 1893 / Member, Nov. 1899
Robinson, Francis, The Vicarage, Willington Quay-on-Tyne ... ... (E) { Graduate, Nov. 1897 / Member, Jan. 1902
Robinson, W., 10, Willow Avenue Crescent, Aulaby Road, Hull ... ... (E) { Graduate, May 1895 / Member, April 1888
Robson, David M., 11, Village Terrace, South Shields... ... (E) Nov. 1899
Robson, George, 9, Wellington Terrace, South Shields ... ... (E) Oct. 1889
Robson, George ... ... (E) Feb. 1896
Robson, John H., 22, Eversley Place, Heaton, Newcastle-upon-Tyne (E) Nov. 1885
Robson, John Hayes, 1, Claremont Terrace, South Shields ... (S) Feb. 1902
Robson, J. M., 4, Abbey Terrace, Gateshead-on-Tyne ... ... (E) Nov. 1884
Robson, M., 20, Tavistock Place, Sunderland ... ... (S) Nov. 1884
Robson, Nathaniel E., 5, Park Villas, The Green, Wallsend-on-Tyne ... ... (E) { Graduate, Dec. 1894 / Member, Nov. 1897
Robson, Robert, 5, St. Mary's Place, Newcastle-upon-Tyne (EE) { Graduate, Dec. 1894 / Member. Mar. 1901
Rodgerson, Wm. John, Engine Department, Carron Works, Falkirk, Stirlingshire ... ... (E) Nov. 1901
Roger, Robert, Stockton Iron Foundry, West Row, Stockton-on-Tees (E) Nov. 1888
Rogers, Herbert M., Redcliffe, Durham Avenue, Bromley, Kent (SUR) April 1889
Rolf, George. 8, Bentinck Crescent, Newcastle-upon-Tyne ... (E E) May 1892
Rolland, Alexander, Villa Ruzic, Susak, Fiume, Hungary... ... (E) Mar. 1892
Ropner, Robert, Jun., Hartburn, Stockton-on-Tees ... ... (S) Feb. 1886
Rosenthal, James H., Woodville, 97, Eltham Road, Lee, Kent ... (E) Dec. 1896
Roseti, Capt. G. Sundblad, Callao 1442, Buenos Ayres, Argentine Republic ... ... (N A) June 1896
Ross, Charles, c/o Messrs. Smith's Dock Co., Ltd., High Docks, South Shields ... ... (E) Jan. 1896
Ross, William, 20, Meadow Side, Dundee ... ... (E) May 1893
Routledge, Herbert J., Stapleton House, Jarrow-on-Tyne ... ... (E E) { Graduate, Mar. 1897 / Member, Dec. 1901

ELECTED.

Rowan, Jas., 231, Elliott Street, Glasgow ... ... (E) Nov. 1886
Rowell, G. W., 22, Armstrong Road, New Benwell, Newcastle-upon-Tyne ... ... (E) Feb. 1885
Rowell, H. B., Cleugh Brae, Jesmond East Park, Newcastle-upon-Tyne (*Life Member*) ... ... (S) Nov. 1884
Roxburgh. Allan B., 21, Grafton Road, Whitley Bay, Northnmberland ... ... (E) Jan. 1902
Rusden, L., 14, Sanderson Road, Jesmond, Newcastle-upon-Tyne (E) Nov. 1884
Russell, F. Herbert, Scotia Engine Works, Sunderland ... ... (E) Oct. 1891
Rutherford, J. T., 39, Osborne Road, Stroud Green Road, London, N. ... ... (E) { Graduate, Jan. 1886 / Member, Nov. 1893
Rutherford, Robert T., 34, Denmark Street, Gateshead-on-Tyne ... (E) Nov. 1899
Ryder, C. L., Messrs. The London Salvage Association, Mount Stuart Square, Cardiff ... ... (E) Oct. 1886

S.

Salmon, P., 5, The Oaks West, Sunderland ... ... (E SUR) Nov. 1884
Sandeman, John Watt, 1, St. Nicholas' Buildings, Newcastle-upon-Tyne... ... ... (E) Oct. 1891
Sanderson, J., 31, Park Road, Jarrow-on-Tyne ... ... (S) Nov. 1884
Sawyer, John, c/o Messrs. Thos. Wilson, Sons, & Co., Hull ... (E) Oct. 1886
Schaeffer, A. G., 16, Lombard Street, Newcastle-upon-Tyne ... (E) Nov. 1884
Scott, Ernest, Close Engine Works, Newcastle-upon-Tyne ... (E E) Nov. 1884
Scott, George, 36, Bede Burn Road, Jarrow-on-Tyne ... (S) { Graduate, Jan. 1900 / Member, May 1901
Scott, James, Selby Lodge, Consett, Co. Durham ... ... (E) Oct. 1892
Scott, Joseph, 49, Leazes Terrace, Newcastle-upon-Tyne (E) { Graduate, Dec. 1891 / Member, Oct. 1898
Scott, Joseph R., 9, Queen Street, Newcastle-upon-Tyne ... ... (E) Oct. 1887
Scott, Walter, 28, Hollybrook Road, Clontarf, Dublin ... ... (NA) Mar. 1897
Scott, William, c/o Messrs. R. & W. Hawthorn, Leslie & Co., St. Peter's, Newcastle-upon-Tyne ... ... (E) Nov. 1884
Scott, William, Lyndhurst, 19, Plasturton Avenue, Cardiff ... (E) June 1896
Seabury, Edward, Burnt Mill House, Harlow, Essex ... ... (E) Mar. 1886
Seaman, C. J., Vyrinen House, Old Trafforth, Manchester ... (E) Jan. 1889
Seaton, Albert Edward, Wilton House, Holderness Road, Hull ... (E) Jan. 1891
See, Horace, 1, Broadway, New York City, U.S.A.... ... ... (E) May 1896
Sergent, William John, 12, College Avenue, Crosby, near Liverpool ... ... (E) Oct. 1898
Shand, H., 6, Akenside Terrace, Newcastle-upon-Tyne ... ... (E) Nov. 1884
Sharp, A. E., c/o Messrs. The Peninsular and Oriental Steam Navigation Co., 122, Leadenhall Street, London, E.C. ... (E) Nov. 1884
Sharp, Mark, 144, Albert Road, Jarrow-on-Tyne ... ... (E) Dec. 1889
Shaw, Thomas, Messrs. Lloyd's Register of Shipping, Collingwood Buildings, Newcastle-upon-Tyne ... ... (SUR) Nov. 1900
Sheriff, Thomas. c/o Messrs. Robert Mackill & Co., 53, Bothwell Street, Glasgow ... ... (E) April 1890
Short, John Gill, East Side, Tyne Dock, South Shields ... ... (NA) Feb. 1899
Short, Jos., 13, John Street, Sunderland ... ... (S) Nov. 1884
Short, Thomas S., c/o Messrs. Short Brothers, Pallion, Sunderland ... ... (S) { Graduate, Oct. 1892 / Member, May 1899

ELECTED.

Shute, A. E.. 12, Clyde View, Partick, Glasgow ... ... (E) Dec. 1892
Sibun, William, Lloyd's Register of Shipping, Bute Docks, Cardiff ... ... (SUR) Mar. 1896
Sinclair, Charles E., 18, James Street, Liverpool ... ... (C E) Jan. 1902
Singleton, Thomas, 46, Drury Buildings, Water Street, Liverpool (F) Apr. 1903
Sinton, John K., Bentham Buildings, 37, Side, Newcastle-upon-Tyne (E) Nov. 1885
Sisson, Wm.. Gloucester ... ... (E & N A) Oct. 1888
Sivewright, G. W., 5, Radcliffe Terrace. Hartlepool ... ... (S) Nov. 1886
Skentelbery, Charles, c/o Messrs. Jacobs, Davies, and Barringer, 153, Mick Street, Boston, U.S.A. ... ... (E) Oct. 1900
Skentelbery, Joseph W., 7, Washington Terrace, North Shields ... (E) Dec. 1900
Skentlebury, G. Arthur, 22, Lansdowne Terrace, Gosforth, Newcastle-upon-Tyne ... ... (S) Oct. 1902
Skinner, Leslie, Westoe, South Shields ... ... (S) { Graduate, Dec. 1886 / Member. Oct. 1891
Smissen, C. V. Van Der, Oben Borgfelde 28, Hamburg ... ... (E) Dec. 1901
Smith, C. E., Gowesby, Clifton Avenue, West Hartlepool ... (E) Nov. 1888
Smith, E. J., Brandon House, Haughton-le-Skerne, Darlington ... (E) Dec. 1900
Smith, L. Eustace, Roseworth Cottage, Moor Road, Gosforth, Newcastle-upon-Tyne ... ... (E) { Graduate. Oct. 1889 / Member. Oct. 1892
Smith, Thomas, Steam Crane Works, Old Foundry, Rodley, near Leeds (E) Oct. 1888
Smith, Thomas Edward, Messrs. John Smith & Sons, Newgate Street, Newcastle-upon-Tyne ... ... (E) April 1885
Smith, Wm., 152, Roker Avenue, Sunderland, M. ... ... (E) Nov. 1884
Smith, Wm. Stawart, West Villa, The Green, Wallsend-on-Tyne ... ... (S) { Graduate, Nov. 1893 / Member, Dec. 1897
Sneddon, Alex. Russell, Lloyd's Register of Shipping, Collingwood Buildings, Newcastle-upon-Tyne ... ... (E SUR) Nov. 1899
Snell, John F. C., Borough Electrical Engineer, Sunderland Corporation Electricity Department, Central Offices. Sunderland ... ... (E E) Mar. 1902
Snook, Francis W. G. ... . (E) Dec. 1896
Soliani, Nabor, Col., Direttore del Cantiere Ansaldo, Sestri-Ponente, Italy ... ... (S) Jan. 1885
Spark, H. King, Messrs. The Anti-Attrition Metal Co., Ltd., Emerson Street, Southwark, London, S.E. ... ... (E) May 1898
Spearman, Richard, Eachwick House, Dalton, Newcastle-upon-Tyne (E) Feb. 1889
Spence, W G., c/o Messrs. Swan, Hunter & Wigham Richardson, Ltd., Neptune Works, Walker-on-Tyne (*Life Member*) ... (E) Nov. 1884
Spencer. J. W., Newburn Steel Works, Newburn-on-Tyne ... (E) Feb. 1885
Squire, Charles E., c/o Messrs. British Insulated and Helsby Cables Co., Limited, Prescot, Lancashire ... (E E) { Graduate, Nov. 1893 / Member, Oct. 1898
Staig, William Andrew, Station Road, Wallsend-on-Tyne ... (E) Feb. 1897
Stanley, John T., 70, Falmouth Road, Heaton, Newcastle-upon-Tyne ... ... (E) Oct. 1898
Stansfield, George R., 1, Linden Gardens, Harton Village, South Shields ... ... (E) Mar. 1891
Stephen, A. E., Linthouse, Govan, Glasgow ... ... (E & S) June 1896
Stephen, John Murray, Linthouse Engine Works, Govan, Glasgow (E) Oct. 1895
Stephens, H. C. J., 94, Fortress Road, Kentish Town, London, N.W. ... ... (E) { Graduate, Oct. 1890 / Member. Nov. 1897

Stephens, Thomas S. ... ... (E Apr. 1901
Stephenson, Bernard, 42, Clincart Road, Mount Florida, Glasgow (I Dec. 1900
Stephenson, C., 2, Elm Terrace, The Green, Wallsend-on-Tyne ... (S) Nov. 1884
Stevenson, Robert, Bentham Buildings, The Side, Newcastle-upon-Tyne ... ... (E) Oct. 1900
Stevenson, Wm., 1, Mosley Street, Newcastle-upon-Tyne... ... (E) Nov. 1884
Stewart, James, 13, Otterburn Terrace, Jesmond, Newcastle-upon-Tyne... ... ... (E) Oct. 1890
Stirling, Andrew, Jun., 1, Greenvale Terrace, Dumbarton... ... (E) Feb. 1888
Stirling, John F., Gilliat House, North Road, Darlington ... ... (F M) Oct. 1902
Stirzaker, J. C., 16, Grosvenor Place, Newcastle-upon-Tyne ... (E) Nov. 1884
Stoddart, A. Lane, York House, Heworth Village, Felling-on-Tyne, R.S.O. ... ... (S) Nov. 1898
Stoddart, J. E., Lloyd's Register of Shipping, 71, Fenchurch Street, London, E.C. ... ... (E SUR) Oct. 1888
Stoney, Gerald, c/o Messrs. C. A. Parsons & Co., Turbinia Works, Heaton, Newcastle-upon-Tyne ... ... (E) May 1902
Stuart, John, 57, Heaton Park Road, Newcastle-upon-Tyne (E) { Graduate, Dec. 1895 / Member, Nov. 1901
Stupersky, Antony, Elsdon Terrace, Percy Main ... ... (S) May 1901
Summers, James, 4, Vicarage Terrace, Newtown, Stockton-on-Tees ... ... (E) Mar. 1889
Surtees, Charles, 42, Stansfield Street, Sunderland ... ... (S) Dec. 1900
Surtees, R., 22, Alexander Terrace, Gateshead-on-Tyne ... (E) Nov. 1884
Swainston, William, 103, Cardigan Terrace, Heaton, Newcastle-upon-Tyne ... ... (FM) Nov. 1900
Swan, A. S., Printing Court Buildings, Newcastle-upon-Tyne ... (S) Nov. 1888
Swan, Charles Sheriton, c/o Messrs. Swan, Hunter & Wigham Richardson, Ltd., Wallsend-on-Tyne ... ... (S) { Graduate, Nov. 1890 / Member, Mar. 1894
Swan, H. F., North Jesmond, Newcastle-upon-Tyne (*Life Member*) (S) Nov. 1884
Swinburne, M. W., The Cottage, Jesmond Park, Benton Road. Newcastle-upon-Tyne ... . (E) Nov. 1884
Swinburne, Matthew, 7, Frazer Terrace, Heworth, Felling-on-Tyne ... ... (S) { Graduate, May 1899 / Member, April 1901
Swinburne, T. M., 18, Bewick Road, Gateshead-on-Tyne ... ... (E) Jan. 1885
Swinney, W., 10, Wentworth Terrace, Westoe Lane, South Shields (E) Dec. 1888
Syme, James, Fairfield Works, Govan, Glasgow ... ... (E) Oct. 1892

T.

Tate, Chas. H., 7, Side, Newcastle-upon-Tyne ... ... (N A) Nov. 1884
Taylor, Alexander, Maritime Buildings, King Street, Newcastle-upon-Tyne . . .. (E) Nov. 1884
Taylor, J. T. Lloyd, Dock Engineer's Office, Middleton Road, West Hartlepool ... ... (CE) May 1903
Taylor, John, 1, St. Alban's Place, Tynemouth ... ... (E) Dec. 1894
Taylor, Martin B., 3, Park Villas, The Green, Wallsend-on-Tyne ... (S) Jan. 1903
Teasdale, John, c/o Messrs. Vickers, Son & Maxim, Naval Construction Works, Barrow-in-Furness ... ... (E) Mar. 1898
Terry, F. Herbert, Messrs. Tyne Brass and Copper Tube Manufacturing Co., Jarrow-on-Tyne ... ... (M) Feb. 1901

ELECTED.

Thackrah, John, 43, Ashleigh Grove. West Jesmond, Newcastle-upon-Tyne ... ... (E) Nov. 1901
Thew, Charlton, 80, Osborne Road. Newcastle-on-Tyne ... ... (E) Nov. 1902
Thomas, Benjamin, 8, Balmoral Terrace, Heaton, Newcastle-upon-Tyne ... ... (E) Feb. 1899
Thomas, Harold, c/o Messrs. The Selby Shipbuilding and Engineering Co., Selby ... ... (S) Apr. 1903
Thomas, William, 4, Eton Avenue, Hampstead, London, N.W. ... ... (E) Graduate, Oct. 1895; Member, Nov. 1899
Thompson, Arthur E., 10, Gowan Villas, Jesmond, Newcastle-upon-Tyne... ... ... (E) May 1898
Thompson, C. E., Thornbeck, Thornhill Park, Sunderland ... (S) Nov. 1884
Thompson, Jas., 2, Carlton Terrace, Sunderland ... ... (E) Dec. 1886
Thompson, J. L., Westholme Hall, Winston-on-Tees ... ... (S) Nov. 1884
Thompson, Joseph Andrew, Langham Tower, Sunderland ... (S) Nov. 1901
Thompson, Robert Norman, Langham Tower, Sunderland ... (S) Nov. 1901
Thompson, Robert, North Sands Shipyard, Sunderland ... ... (S) Nov. 1884
Thomson, James, M.A., 22, Wentworth Place, Newcastle-upon-Tyne... ... . (E & N A) Nov. 1890
Thorn, W. H., 5, Waterville Terrace, North Shields ... ... (E) Nov. 1884
Thornton, James M., c/o Messrs. R. Gordon & Co., Post Office Buildings, Hudson Street, South Shields ... ... (E) April 1893
Thyne, John Sinclair, 32, Azalea Terrace N., Sunderland ... ... (S) Dec. 1899
Tinn, Fred. D., North View, Mowbray Road, South Shields ... (S) Nov. 1891
Tinn, George, 205, Cardigan Terrace, Gateshead-on-Tyne ... ... (E) Dec. 1897
Tocher, J. W., c/o Messrs. Wallsend Slipway and Engineering Co., Wallsend-on-Tyne ... ... (S) Mar. 1898
Todd, George William, 53, Victoria Road, Hebburn-on-Tyne (S) Graduate, Jan. 1898; Member, Dec. 1899
Todd, John P., 21, Stephen Street, Edge Lane, Stretford, near Manchester ... ... (E) Dec. 1897
Todd, William Surtees, Coronation Buildings, Quayside, Newcastle-upon-Tyne ... ... (N A) Nov. 1901
Toomer, C. R., Ravensworth, Westoe, South Shields ... ... (E) Jan. 1899
Toovey, Alfred F., 28, Burdon Terrace, Newcastle-upon-Tyne ... (E) Dec. 1894
Tose, Thomas, 171, Earlam Grove, Forest Gate, Essex ... ... (E) Mar. 1901
Towers, Edward, Jun., 27, Brandling Park, Newcastle-upon-Tyne ... ... (E) Graduate, Nov. 1886; Member, Oct. 1888
Trail, John, 21, Grosvenor Place, Jesmond, Newcastle-upon-Tyne ... ... (M S) Oct. 1892
Traill, Robert, 6, Windsor Crescent, Whitley Bay, Northumberland (E) Oct. 1896
Trechmann, J. E., Norton Lodge, Stockton-on-Tees ... ... (E) Feb. 1898
Trewent, F. J., 43, Billiter Buildings, Billiter Street, London, E.C. ... ... (S) Dec. 1884
Trowell, Wm. John, Chief Inspector of Marine Surveyors, Singapore (E) Oct. 1894
Tsimenis, Andrew, Durham College of Science, Newcastle-upon-Tyne ... ... (N A) Graduate, Oct. 1900; Member, Jan. 1902
Turnbull, John, 103, Warton Terrace, Heaton, Newcastle-upon-Tyne (E) Nov. 1898
Turner, Charles N., 21, Lansdowne Terrace, Gosforth, Newcastle-upon-Tyne ... ... (E) Graduate, April 1896; Member, Dec. 1901
Turner, S. J., 71, Warwick Street, Heaton, Newcastle-upon-Tyne (E) Mar. 1887

ELECTED.

Turpie, David Whyte, c/o Messrs. W. Pickersgill & Sons, Southwick, Sunderland ... ... (S) Dec. 1895
Tuxen, Holger, Bureau Veritas Register of Shipping, Heibersgade, 14, Copenhagen, K. ... ... (S) Nov. 1896
Twaddell, James L., Green Bank, Jarrow-on-Tyne ... ... (S) Oct. 1891
Tweedy, G. F., 1, Grosvenor Villas, Jesmond, Newcastle-upon-Tyne (E) May 1899
Tweedy, John, Kelso House, Fernwood Road, Jesmond, Newcastle-upon-Tyne ... ... (E) Nov. 1884
Tweedy, John, 5, Bellevue Terrace, North Shields ... ... (E) April 1899

U.

Ulm, John, The Arsenal, Pola, Austria ... ... (E) Nov. 1885
Urquhart, Douglas M., 13, Gill Side Grove, Roker, Sunderland ... (S) May 1899

V.

Vardy, George, c/o Messrs. Swan, Hunter & Wigham Richardson, Ltd., Neptune Works, Newcastle-upon-Tyne (E) { Graduate, Oct. 1894 / Member, 1898
Varty, Bartholomew Snowball, Drawing Office, c/o Messrs. Fairfield Shipbuilding Co., Govan, Glasgow ... (S) { Graduate Oct. 1895 / Member May 1901
Vianson, N. E., *vid* Corsica 20/5, Genoa, Italy ... ... (E) Dec. 1885
Vick, R. W., Messrs. Furness, Withy & Co., Middleton Shipyard, West Hartlepool ... ... (S) Nov. 1888
Vowell, Josias, S.S. "Bida," c/o Messrs. Elder, Dempster & Co., Luineshof Newgroingerstrasse 1, Hamburg ... ... (E) Feb. 1901

W.

Wadagaki, Yasuzo, Navy Department, Tokio, Japan ... ... (E) Jan. 1891
Waddington, William H., 5, Claremont Terrace, Newcastle-upon-Tyne ... ... (E) Dec. 1902
Wailes, William C., 23, Richmond Road, Cardiff ... (E) { Graduate, Nov. 1898 / Member, Nov. 1901
Wait, Thomas Herbert, Cail's Buildings, Quayside, Newcastle-upon-Tyne ... ... (C E) Dec. 1893
Wake, Tom, 14, Bellesley Terrace, West Hartlepool ... ... (E) April 1892
Walker, Archibald, 143, Leith Walk, Leith, N.B. ... ... (E) April 1887
Walker, Henry, 9, Gladstone Terrace, Gateshead-on-Tyne ... (E E) Feb. 1893
Walker, James, c/o Messrs. River Tyne Commissioners' Office, Bewick Street, Newcastle-upon-Tyne ... ... (C E) Nov. 1898
Walker, John, c/o Messrs. R. Stephenson & Co., Limited, South Street, Newcastle-upon-Tyne ... ... (E & S) Nov. 1891
Walker, Sept. H., 37, Washington Terrace, North Shields ... (E) Nov. 1899
Wallau, J., 16, Woodhouse Terrace, Gateshead-on-Tyne ... ... (E) Nov. 1884
Waller, Thomas Naunton, Rushmere, Wylam-on-Tyne ... ... (E) May 1898
Wallis, Robert, Wh.Sc., Point Pleasant House, Wallsend-on-Tyne (E) April 1891
Walter, Max, Norddeutscher Lloyd, Central Bureau, Bremen ... (S) Feb. 1893
Walton, J. G., 26, Fenchurch Street, London, E.C. ... ... (E) Nov. 1884
Walton, Samuel, 5, Tyne View Terrace, South Shields ... ... (E) Dec. 1893
Warburton, F. J., 3, St. Nicholas' Buildings, Newcastle-upon-Tyne (C E) May 1900
Warburton, J., Greenlands, Cleadon, near Sunderland ... ... (S) Nov. 1884

ELECTED.

Warburton, John Arthur, 13, Grindon Terrace, Sunderland (E) — Graduate, Mar. 1894; Member, Nov. 1896

Ward, Herbert John, The Mill House, Farningham, Kent ... (SUR) Nov. 1898

Ward, John, c/o Messrs. W. Denny & Bros., Dumbarton ... ... (S) Dec. 1891

Wardale, Henry, 9, Woodhouse Terrace, Gateshead-on-Tyne ... (E) Feb. 1888

Watson, John, 62, Wandsworth Road, Heaton, Newcastle-upon Tyne ... ... (S) — Graduate, Dec. 1897; Member, Dec. 1901

Watson, Michael, 4, St. Nicholas Buildings, Newcastle-upon-Tyne (C E) Oct. 1900

Watson, Thomas Henry, 10, Neville Street, Newcastle-upon-Tyne (SUR) Jan. 1896

Watts, Philip, Cedarcroft, Putney Heath, London, S.W. ... ... (S) Nov. 1885

Wawn, Tom Noel, c/o Messrs. Lloyd's Register of Shipping, Dock Chambers, Barry, South Wales ... ... (SUR) Jan. 1900

Webster, William Milne, 22, Lesbury Road, Heaton, Newcastle-upon-Tyne ... ... (E) Nov. 1900

Weidemann, Nils, Det-Norske Veritas, Christiania, Norway ...(SUR) Jan. 1892

Weighton, R. L., M.A., 2, Park Villas, Gosforth, Newcastle-upon-Tyne ... ... (E) Nov. 1884

Weir, George Dobie, Sunderland Engine Works, South Docks, Sunderland ... ... (E) Oct. 1894

Weir, John, 46, Lawrence Street, Partick, Glasgow ... ... (E) Nov. 1884

Weir, William, 190, Nithsdale Road, Pollokshields, Glasgow ... (E) Nov. 1889

Welton, J. G.. 41, Sydenham Terrace, Sunderland .. .. (E) Nov. 1893

West, Henry H., British and Foreign Chambers, 5, Castle Street, Liverpool ... ... (E & N A) Oct. 1886

Westgarth, Tom, Messrs. Richardsons, Westgarth & Co., Middlesbrough ... ... (E) Oct. 1886

Westmacott, Alfred, Clairvaux, Nettlestone, Isle of Wight ... ... (E) — Graduate, Dec. 1885; Member, Nov. 1892

Westmacott, P. G. B., Rose Mount, Sunninghill, Berks ... ... (E) Nov. 1884

Wheater, Chas. Busfield, 73, Rothbury Terrace, Heaton, Newcastle-upon-Tyne ... ... (E) Oct. 1894

White, A. F., c/o Messrs. Nippon Yusen Kaisha, Tokyo, Japan ... (E) Feb. 1901

White, C., 13, Mosley Street, Newcastle-upon-Tyne ... ... (E) Nov. 1884

White, R. Saxon, Messrs. Sir W. G. Armstrong, Whitworth & Co., Ltd., Walker Shipyard, Walker-on-Tyne ... ... (S) Nov. 1884

Whitfield, Ernest, 11, Victoria Terrace, Low Fell, Gateshead-on-Tyne... ... ... (E) Dec. 1899

Whitfield, Thomas, Messrs. Tyne Dock Engineering Co., South Shields ... ... (E) April 1896

Whyte, James Anderson, 196, Watt Street, Glasgow ... ... (E) May 1902

Whyte, Wm., Eastrigg, Corbridge-on-Tyne ... ... (E) Nov. 1884

Widdas, T. D., 56, Plasturton Avenue, Cardiff ... ... (SUR) April 1885

Widdowfield, John H.. 3, Beaconsfield Terrace, Gateshead-on-Tyne (E) Nov. 1901

Wight, Henry D., 7, Holmlands Park, Sunderland ... ... (E E) Dec. 1898

Wildridge, Richard, c/o R. W. Brachead, Bury Street, N. Sydney, N.S.W. ... ... (E) — Graduate, Oct. 1895; Member, Oct. 1898

Wilkin, Ernest V., 11, Appold Street, Finsbury, London, E.C.... ... ... (C E) — Graduate, Nov. 1892; Member, Oct. 1898

Wilkinson, Thomas, 9, Laburnum Avenue, Wallsend-on-Tyne ... (S) Nov. 1899

Willcox, Henry Walker, 15, Norfolk Street, Sunderland ... ...(C E) Nov. 1897

Willcox, Percy F. C., 15, Norfolk Street, Sunderland ... ...(C E) Nov. 1897

ELECTED.

Willcox, R. J. N., c/o Messrs. Fleming & Ferguson, Ltd., Shipbuilders and Engineers, Paisley ... (E) Graduate, Mar. 1892; Member, Dec. 1897

Williams, M. Lucas, 19, Barratt Street, Stockton-on-Tees .. ... (E) Nov. 1900

Williams, Thomas, Messrs. South Durham Steel & Iron Co., West Hartlepool ... ... (I & S M) Dec. 1900

Williams, Thomas R.. "Holmeside," 142, Bede Burn Road, Jarrow-on-Tyne ... ... (S) Oct. 1895

Williamson, Robt. Tate, 119, Bede Burn Road, Jarrow-on-Tyne ... (E) Oct. 1900

Wilson, B.Sc., Alfred Carruthers, 97, Park Road, Wallsend-on-Tyne (E) Nov. 1901

Wilson, Edmund, Leazes Park, Newcastle-upon-Tyne ... ... (E) Nov. 1901

Wilson, Henry J. H., "Lancefield," Kellfield Avenue, Low Fell, Gateshead-on-Tyne ... ... (E) Nov. 1895

Wilson, Henry Maxson, 4, Thomas' Square, Newcastle-upon-Tyne (E) May 1902

Wilson, James, Messrs. Richardsons, Westgarth & Co., Hartlepool Engine Works, Hartlepool ... ... (E) Jan. 1896

Wilson, John Paul, 123, Osborne Road, Jesmond, Newcastle-on-Tyne (S) Oct. 1895

Wilson, John Reginald, Lyndhurst, Gosforth, Newcastle-upon-Tyne ... ... (E E) Graduate, Mar. 1894; Member, Dec. 1899

Wilson, William S., 123, Osborne Road, Jesmond, Newcastle-upon-Tyne ... ... (E E) Graduate, Nov. 1891; Member, Mar. 1901

Wimble, Arthur, 1, Queen Street, Jersey ... ... (E) Dec. 1893

Winstanley, P. D., Bureau Veritas Register of Shipping, 155, Fenchurch Street, London ... ... (S) Nov. 1884

Withy, H., Middleton Shipyard, West Hartlepool ... ... (S) Nov. 1884

Wood, Henry Alfred, Oakfield Road, North Ormesby, Middlesbrough-on-Tees ... ... (S) Dec. 1893

Wood, John Scott, 6, Eslington Terrace, Newcastle-upon-Tyne ... ... (S) Graduate, Oct. 1891; Member, Oct. 1896

Wood, Lionel, 4, Simonside Terrace, Heaton, Newcastle-upon-Tyne (E E) Jan. 1903

Wood, William, 6, Eslington Terrace, Newcastle-upon-Tyne ... (S) Nov. 1897

Woodeson, Wm. A., 13, Richmond Terrace. Gateshead-on-Tyne ... (E) Nov. 1901

Wortley, Henry B., Kent House, Egerton Park, Rock Ferry, Birkenhead... ... ... (S) Graduate, Jan. 1886; Member, Nov. 1892

Wotherspoon, James Douglas, 39, Hainton Street, Grimsby ... (E) April 1900

Wray, Thomas W., Board of Trade Offices, Sunderland ... ...(SUR) Jan. 1895

Wright, George H., 23, Albury Park Road, Tynemouth (EE) Graduate, Feb. 1896; Member, Dec. 1901

Wright, R., 5, Hawthorn Terrace, Newcastle-upon-Tyne ... ... (E) Nov. 1884

Wynd, William Adam, 8, Dilston Terrace, Gosforth, Newcastle-upon-Tyne ... ... (N A) Feb. 1902

Wyse, Thomas. North Lodge, Walker-on-Tyne ... ... (E) Nov. 1898

Y.

Young, Andrew, Bureau Veritas, Register of Shipping, 155, Fenchurch Street, London, E.C. ... ... (S) Graduate, Feb. 1892; Member, May 1893

Young, J. Denholm, 6, Commercial Court, 17, Water Street, Liverpool ... ... (E) Oct. 1888

Younger, R. Elmire House, Heaton, Newcastle-upon-Tyne ... (E) Nov. 1884

Z.

Zeeman, J. H. ... ... (S) Oct. 1889

ASSOCIATES.

A.

ELECTED.

Anderson, Daniel G., c/o Messrs. W. Angus & Co., Grainger Street West, Newcastle-upon-Tyne ... ... (A) Nov. 1893
Armstrong, S., Victoria Road, West Hartlepool ... ... (A) Nov. 1888
Armstrong, Thomas Henry, c/o Messrs. British Uralite Co., 50 Cannon Street, London, E.C. ... ... (E A) Nov. 1900
Arnott, James, 25, Dean Street, Newcastle-upon-Tyne ... (S O) Oct. 1895

B.

Barklam, George, Burnt Tree Villa, Tipton, Staffordshire ... (A) April 1888
Barr, John Smith, 16, Broad Chare, Quayside, Newcastle-upon-Tyne... ... ... (A) Nov. 1893
Barnes, Henry, 43, Otto Terrace West, Sunderland ... ... (A) Nov. 1901
Barwick, J. S., Ashbrook Grange, Sunderland ... ... (S O) Nov. 1884
Beynon, Thomas, Hamburg Chambers, Quayside, Newcastle-upon-Tyne ... ... (E A) Oct. 1891
Bigge, C. W., Northern Counties Club, Newcastle-upon-Tyne ... (A) Dec. 1889
Bingham, Col. J. E., West Lea, Ranmoor, Sheffield... ... ... (M) Mar. 1895
Bird, William, 22, Percy Gardens, Tynemouth ... ... (A) May 1896
Borrie, Walter, Messrs. Blair & Co., Ltd., Stockton-on-Tees ... (A) Jan. 1899
Bowmer, John J., 8, Tankerville Terrace, Newcastle-upon-Tyne... (S O) Nov. 1901
Brims, D. N., 4, St. Nicholas' Buildings, Newcastle-upon-Tyne ... (C) Nov. 1893
Brown, Charles Ernest, 1, Ashleigh Villas, East Boldon, near Sunderland,... ... ... (A) Oct. 1900
Brown, Percy Ledger, 1, St. Nicholas' Buildings, Newcastle-upon-Tyne ... ... (E A) Oct. 1896
Brunton, John, 3, Prior's Terrace, Tynemouth ... ... (S O) Oct. 1886
Bullen, Tempest C., c/o Messrs. H. E. Moss & Co., K, Exchange Buildings, Newcastle-upon-Tyne ... ... (S O) Nov. 1891

C.

Carr, Ralph, Thornleigh, Clayton Road, Newcastle-upon-Tyne (A & S O) Nov. 1886
Caws, Frank, 22, Fawcett Street, Sunderland ... ... (C E) Oct. 1892
Cay, Arthur, Messrs. Cay, Hall & Co., Exchange, Cardiff ... ... (S O) Nov. 1884
Cohan, Edward Asher, 2, Rumford Place, Liverpool ... ... (S O) Nov. 1889
Cory, John, Mount Stuart House, Cardiff ... ... (S O) June 1896
Coull, John, Baltic Chambers, Quayside, Newcastle-upon-Tyne ... (S O) Oct. 1886
Crawford, Thomas, 10, Haldane Terrace, West Jesmond, Newcastle-upon-Tyne ... ... (A) Oct. 1896
Crosier, Edward James, 3, The Hawthorns, East Boldon ... ... (A) Oct. 1889
Culley, F. I., 15, Northumberland Terrace, Tynemouth ... ... (A) Nov. 1899
Culliford, J. H. W., 45, West Sunniside, Sunderland ... ... (S O) Nov. 1884

D.

Dixon, Thomas, c/o Messrs. Sir Raylton Dixon & Co., Ltd., Shipbuilders, Middlesbrough ... ... (A) May 1902
Dodds, E. F., 36, Side, Newcastle-upon-Tyne ... ... (A) Nov. 1893
Dodds, John B., 36, Side, Newcastle-upon-Tyne ... ... (CHEM) Oct 1888
Donkin, Geo., Jun., 50, Grove Street, Newcastle-upon-Tyne ... (A) April 1897
Dove, Edward John, 5, St. Nicholas' Buildings, Newcastle-upon-Tyne ... ... (M) Oct. 1890
Douglas, John, c/o Messrs. Walker & Hall, 60, Grey Street, Newcastle-upon-Tyne ... ... (A) Oct. 1898

E.

ELECTED.

Eccles, Edward, Royal Insurance Buildings, Queen Street, Newcastle-upon-Tyne (*Life Associate*) ... ... (S O) Oct. 1887
Elder, George H., Cail's Buildings, Quayside, Newcastle-upon-Tyne (S O) Feb. 1903
Evans, Fred. George, 10, Neville Street, Newcastle-upon-Tyne ... (A) Nov. 1901

F.

Fellows, Alfred, Bergholt House, Park Road, Jarrow-on-Tyne (I & S M) Nov. 1901
France, James A., St. John Street, Newcastle-upon-Tyne ... (M) Jan. 1898
Frazer, Joseph S., Britannia Buildings, Cardiff . ... .. (M) June 1896
Furness, Sir Christopher, Baltic Chambers, West Hartlepool . (S O) Oct. 1888
Forster, George, 8, Warwick Street, Heaton, Newcastle-upon-Tyne Oct. 1898

G.

Gaunt, Richard, Albany Villa, Eaglecliff, R.S.O. ... ... (A) Oct. 1902
Geary, William, 6, Chaloner Terrace W., South Shields ... ... (M S) May 1899
Gore, Thomas Hoskins, 52, Queen's Square, Bristol ... ... (S O) April 1902
Graham, Frank, 21, Groat Market, Newcastle-upon-Tyne ... (E A) Nov. 1891

H.

Hardy, John, Jun., Victoria Road, West Hartlepool ... ... (I M) Nov. 1893
Harland, George, 1, Westoe Crescent, South Shields .... (A) Dec. 1888
Harris, John T., c/o Messrs. Irvine's Shipbuilding Co., Ltd., West Hartlepool ... ... (A) Mar. 1902
Harrison, Samuel Turner, The Green, Wallsend ... ... (A) Nov. 1897
Harrison, Thomas, 9, Bridge Street, Sunderland ... ... (A) Dec. 1894
Hedley, John H., 7, Ashbrook Terrace, Sunderland... ... ... (S) Dec. 1886
Hedley, Robert, 3, Summerhill Grove, Newcastle-upon-Tyne ... (A) Nov. 1899
Henderson. John T., 5, Logan Terrace, South Shields ... ... (M) May 1900
Henzell, Chas. Wright, D, Exchange Buildings. Lombard Street, Newcastle-upon-Tyne ... ... (A) Nov. 1901
Henzell, Robert, Northern Oil Works, Newcastle-upon-Tyne (*Life Associate*) ... ... (A) Nov. 1893
Heslop, Richard O., M.A., Akenside Hill, Newcastle-upon-Tyne (I & S M) Oct. 1885
Hinchliffe, John, 25, Hawthorn Street, Newcastle-upon-Tyne ... (A) Nov. 1899
Hodges, Thomas Wm., 86, Osborne Road, Newcastle-upon-Tyne ... ... (A) Nov. 1899
Hogg, John Thomas, Tyneside Brass Works, Barry Docks, South Wales ... ... (I & S M) April 1896
Holliday, Henry, Beechgrove, Blackhill, Co. Durham ... ... (A) Nov. 1895
Hollis, John, c/o Messrs. John Brown & Co., Ltd., 144, St. Vincent Street, Glasgow ... ...(S M) May 1901
Holzapfel, Max, Maritime Buildings, Quayside. Newcastle-upon-Tyne ... ... (M) May 1900
Hudson, Ralph M., Jun., 8, The Cedars, Sunderland ... ... (S O) Dec. 1886
Hudson, Robert, 24, Hotspur Street, Tynemouth ... ... (A) Nov. 1895
Hunting, Charles S., 1, Exchange Buildings, Quayside, Newcastle-upon-Tyne ... ...(S O) April 1886

I.

Innes, Charles H., M.A., Rutherford College, Newcastle-upon-Tyne (E) Oct. 1891

J.

ELECTED.

Jennings, Albert Edward, 4, The Crescent, Gateshead-on-Tyne ... (M) Nov. 1901
Jobson, W. J., 29, Malvern Street, Newcastle-upon-Tyne ... (A) May 1889
Jordan, John George, 6, Cedars Crescent, Ryhope Road, Sunderland ... ... (A) Nov. 1892

K.

King, Ernest, Messrs. Mellowes & Co., Corporation Street, Sheffield ... ... (A) April 1903

L.

Levin, Otto, Maritime Buildings, King Street, Newcastle-upon-Tyne ... ... (A) Nov. 1902
Lockie, John, 21, Dean Street, Newcastle-upon-Tyne .. ... (S O) Oct. 1892
Lodwidge, Philip, Baltic Chambers, Sunderland ... ... (A) June 1896
Lord, W. R., 41, Queen's Road, Jesmond, Newcastle-upon-Tyne ...(M M) Feb. 1900
Lucock, George, Dean House, Tyne Dock ... ... (M) Oct. 1900

M.

Macarthy, George E., 54, Pilgrim Street, Newcastle-upon-Tyne ...(S O) Oct. 1887
Mail, Douglas B., 3, St. George's Terrace, Jesmond, Newcastle-upon-Tyne ... ...(M S) Feb. 1895
Maughan, William, 13, Mosley Street, Newcastle-upon-Tyne ... (A) Feb. 1887
MacIntyre, John, 3, Abbotsford Terrace, Newcastle-upon-Tyne ... (S O) Jan. 1885
McBeath, Harry C., c/o Messrs. John Spencer & Sons, Newburn Steel Works, Newburn ... ... (A) Dec. 1900
Meek, John George, 13, Belle Vue Park, Sunderland .. ... (A) Dec. 1894
Milburn, J. D., Queen Street, Newcastle-upon-Tyne ... ... (S O) Nov. 1884
Miller, T. R., 9, Great St. Helen's, London, E.C. ... ... (A & S O) Nov. 1884
Mitcalfe, John Stanley, Chairman of Northern Maritime Insurance Co., Maritime Buildings, Newcastle-upon-Tyne ... (A & S O) Jan. 1892
Moss, J. Frank, Jr., 48, Clifford Road, Sharow, Sheffield ... ... (S M) Nov. 1901
Mulherion, G. F., Birtley Avenue, Tynemouth ... ... (A) Nov. 1884
Muller, J. C. F., 79, Rue Harringrode, Antwerp ... ...(SUR) Feb. 1890
Murray, Henry H., Hastings Lodge, Hartlepool ... ... (A) Dec. 1901
Murray, Matthew, The Green, Wallsend-on-Tyne ... . (A) Nov. 1893

N.

Naismith, John, Neptune Works, Newcastle-upon-Tyne ... ... (A) Nov. 1901
Nielsen, Hans Christian, 12, Cliff Terrace, Hartlepool ... .. (S O) Feb. 1898
Nixon, John, c/o Messrs. Blyth Shipbuilding Co., Blyth ... ... (A) Oct. 1894

O.

Olsen, Hans Benedick, 70, Church Street, West Hartlepool ... (S O) Mar. 1893

P.

ELECTED.

Park, Robert, Lauriston, Blackhill. Co. Durham ... ... (A) Dec. 1897
Parker, George, 62, John Street, Sunderland ... ... (A) Dec. 1899
Patterson, Thos., 2, The Elms, Sunderland ... ... (S) Jan. 1885
Petersen, William, Messrs. Petersen & Tate, Bank Chambers. Sandhill, Newcastle-upon-Tyne... ... ... (S O) Nov. 1893
Phalp, Oliver, 22, Ninian Road, Cardiff ... . (SUR) Feb. 1889
Pinkney, Thomas, 3, Ashbrook Terrace, Sunderland ... ... (S O) Dec. 1886
Potts, Turnbull, Commercial Buildings. Tyne Docks, South Shields (SUR) Nov. 1898
Pringle, George Frederick, 29, Grainger Street West, Newcastle-upon-Tyne ... ... (E A) May 1901
Proctor, J. H., 22, Hawthorn Terrace, Newcastle-upon-Tyne ... (I M) Nov. 1893
Purvis, Alexander, Albany Chambers, King Street, South Shields (M) Nov. 1901

R.

Raine, John, Baltic Chambers, Sunderland ... ... (S O) Nov. 1897
Ramsay, J. W., 13, Northbrook Road, Lee, Kent ... ... (A) Feb. 1885
Ramsay, Norman F., 20, Sanderson Road, Newcastle ... ... (B F) Jan. 1902
Reichwald, A., Finsbury Pavement House, Finsbury Pavement, London, E.C. ... ... (A) Nov. 1884
Reid, Sidney, Printer, Akenside Hill, Newcastle-upon-Tyne ... Nov. 1884
Renwick, G., M.P., Messrs. Fisher, Renwick & Co., Colllingwood Buildings, Newcastle-upon-Tyne ... ... (S O) Nov. 1884
Rimer, William Thomas, Craigielea. Low Fell, Gateshead-on-Tyne (M) Nov. 1900
Ritson, Arthur, 30, West Sunniside, Sunderland ... ... (S O) Feb. 1899
Robson, John William, Mercantile Chambers, Quayside, Newcastle-upon-Tyne ... ... (M) April 1896
Rogers, Thomas W.. 284, Beverley Road, Hull ... ... (A) May 1901

S.

Scholefield, A., 17, Sandhill, Newcastle-upon-Tyne ... ... (S O) Nov. 1884
Sisson, W. E., 9, Northumberland Terrace, Tynemouth ... ... (A) Nov. 1899
Snowdon, W. F., 32, Side, Newcastle-upon-Tyne ... ... (E A) Dec. 1886
Stallybrass, William S., 30, Dean Street, Newcastle-upon-Tyne ... (M) Mar. 1901
Stephenson, George R., c/o Messrs. N. E. Marine Engineering Co., Northumberland Engine Works, Wallsend ... ... (A) Nov. 1899
Storey, Christopher, 13, Sunbury Avenue, Jesmond, Newcastle-upon-Tyne ... ... (A) April 1896
Sutherland, Arthur M., 7, Collingwood Terrace, Newcastle-upon-Tyne ... ... (S O) Nov. 1897
Swinney, Robt. Nesbit, Messrs. Swinney Bros., Ltd., Morpeth, Northumberland ... ... (A) Nov. 1901

T.

Tate, Arthur, 37, Side, Newcastle-upon-Tyne ... ... (S O) Nov. 1893
Taylor, Edward, Tyneside Works, Scotswood-on-Tyne ... ... (M) Mar. 1902
Taylor. Swainson T., Tyneside Works, Scotswood-on-Tyne ... (M) Mar. 1902
Temple, George T., 20, Beach Avenue. Whitley Bay, Northumberland ... ... (A) Jan. 1899

ELECTED.

Temple, John, Baltic Chambers, Newcastle-upon-Tyne ... (S U R) Mar. 1901
Thompson, John S., 2, Claremont Terrace, Newcastle-upon-Tyne... (A) Nov. 1901
Thompson, V. T., Baltic Chambers, Sunderland ... ...(S O) Dec. 1886
Thompson, Wm. H., 5, Albany Gardens, Whitley Bay, Northumberland .. .. (A) Nov. 1899
Thorpe, Samuel, Market Place, Chambers 74, High Street, Sheffield ... ... (I & S M) Feb. 1901
Todd, John Stanley, Maritime Buildings, Newcastle-upon-Tyne (U) Nov. 1895
Tomkins, Harry, 3, Lorne Terrace, Stockton-on-Tees ... (CONTR) Oct. 1902
Towers, Edward, 27, Brandling Park, Newcastle-upon-Tyne ... (A) Oct. 1888
Towers, Michael G., Clementhorpe, North Shields ... ... (A A) Dec. 1899
Trechmann, Otto K., Church Street, West Hartlepool .. .. (S O) Oct. 1896
Tully, Robert, 9, The Lawe, South Shields ... ... (M S) May 1900
Turner, Edwin, 32, Powell Road, Clapton, London, N.E. ... ... (A) Oct. 1895

W.

Wainford, Edgar H., 106, Cardigan Terrace, Heaton, Newcastle-upon-Tyne ... ... (A) Nov. 1899
Wallace, H. S. (*Life Associate*) ... ... (S) May 1899
Ward, Heber, Messrs. Walker & Hall, Sheffield ... ... (A) Feb. 1901
Wardle, James, 7, Osborne Terrace, Gosforth, Newcastle-upon-Tyne... ... ... (M) Nov. 1901
Watson, Thomas W., Gisburn House, Hartlepool ... ... (M S) Nov. 1890
Weatheral, Henry, 27, Alderson Street, West Hartlepool ... ... (A) Feb. 1893
Weller, William, 7, Lovaine Terrace, North Shields ... ... (S O) Dec. 1899
Wilkie, John William, Prince's Buildings, Quayside, Newcastle-upon-Tyne ... ... (S O) Oct. 1900
Willis, Thomas W., 93, Clifton Avenue, West Hartlepool ... ... (S O) Nov. 1899
Wilson, F. Alfred, 45, West Sunniside, Sunderland ... ... (I M) Nov. 1893
Wilson, James, 61, Falmouth Road, Heaton, Newcastle-upon-Tyne (A) Nov. 1901
Winstanley, Robt. Hope, 8, Kenilworth Road, Newcastle-upon-Tyne (A) Nov. 1897
Winter, E. G., 56, Avenue Road, Gateshead-on-Tyne ... ... (A) May 1898

Y.

Yeoman, F., Ship and Steamship Broker, West Hartlepool ... (S O) Nov. 1888
Young, J. A., St. Ann's Rope Works, Newcastle-upon-Tyne ... (R M) May 1901
Young, John Barrow, Optician, 46, Dean Street, Newcastle-upon-Tyne ... ... Nov. 1901
Younger, Robert Laurie, Messrs. Greenock Steamship Co., Limited, Greenock ... ... (A) Feb. 1889

GRADUATES.

A.

Allan, Percy F., Wansbeck Street, Jarrow-on-Tyne ... ... (E) Nov. 1901
Allen, John C., 20, Mayfair Road, West Jesmond, Newcastle-upon-Tyne... ... ... (E) Dec. 1899
Anderson, Thomas C., Biggea Main House, Wallsend-on-Tyne ... (E) Mar. 1902
Andrew, John Davis, 33, Osborne Road, Newcastle-upon-Tyne ... (E) Jan. 1898
Atkinson, Harry, Belmont Avenue, Wickford, Essex ... ... (E) Nov. 1901

B.

	ELECTED.
Backhouse. A. E., 58, Fern Avenue, Newcastle-upon-Tyne ...	(EE) Mar. 1903
Bailey, Ralph U., 3. South Avenue, Ryton-on-Tyne	(E) Dec. 1901
Barr, Robert, 40. Oxford Street, Barrow-in-Furness	(E) Nov. 1901
Batty, George L., 59, Park Road, Newcastle-upon-Tyne	(EE) Mar. 1903
Bennett, George H., c/o Mrs. Wilson, 21, Woodbine Street, Gateshead-upon-Tyne	(S) Dec. 1900
Berriman, A. E., 130. Cardigan Terrace, Heaton, Newcastle-upon-Tyne	(E E) Feb. 1900
Bolton, Frank, Beaconsfield Square, Hartlepool	(S) May 1903
Bowmer, Matthew N., 8, Tankerville Terrace, Jesmond, Newcastle-upon-Tyne	(E) Dec. 1900
Brown, George M., 21, Westmoreland Road, Newcastle-upon-Tyne	(EE) Mar. 1903
Bullen, Harold, 15, Caroline Street, Jarrow-on-Tyne	(E) Dec. 1902
Burnup, Edward C., 2, Wentworth Place, Newcastle-upon-Tyne	(EE) Mar. 1903
Burr, Percy B., 16, St. George's Terrace, Newcastle-upon-Tyne ...	(E) Dec. 1900

C.

Chicken, George Percy, 17, Kenilworth Road, Newcastle-upon-Tyne...	(E) Dec. 1898
Coaker, William F.. 1, Chester Street, Newcastle-upon-Tyne ...	(E) Nov. 1901
Collin, Albert H.. 23, Castle Street, Leicester	(E) Dec. 1902
Cothay, Frank H., 38, The Avenue, Sunderland	(E) Feb. 1901
Coull, Thomson Bankhead, South Preston, North Shields... ...	(E) Dec. 1902
Crookston, David D., 36, Fountayne Road, Stoke Newington, London	(E) Nov. 1899
Crow, William George, 45. Rye Hill, Newcastle-upon-Tyne ...	(E) Nov. 1900
Cruickshank, Andrew, Park Road, Hebburn-on-Tyne	(E) Nov. 1899
Currie, Hugh B., 48, Jesmond Road, Newcastle-upon-Tyne ...	(E) Nov. 1897
Curry, Albert, 68, Ryehill, Newcastle-upon-Tyne	(E) Nov. 1901
Cuttle, Henry H., 156, Eastbourne Avenue, Gateshead-on-Tyne ...	(E) Jan. 1902

D.

Darby, Harold, Park House, Church End, Finchley	(E) Jan. 1903
Davies. Thomas, 59, Park Road, Newcastle-upon-Tyne	(E E) Mar. 1903
Davison, Joseph P., 107, Clumber Street, Newcastle-upon-Tyne ...	(S) Oct. 1898
Denton, G. P., 63, Osborne Road, Newcastle-upon-Tyne	(S) Jan. 1903
Denton, Hugh K., 63, Osborne Road, Newcastle-upon-Tyne ...	(E) Dec. 1901
Dewar, John, The Green, Wallsend-on-Tyne	(E) Nov. 1899
Dickinson, Thomas, 105, High Park Road, Newcastle-upon-Tyne	(E) Nov. 1901
Dilworth-Harrison, D. R., 17, Granville Street, Gateshead-on-Tyne	(E E) Nov. 1899
Dowsen, Junr., Charles, 21, Croft Terrace, Jarrow-on-Tyne ...	(S) Feb. 1901
Durrant, Aubrey Percy, 72, Rothbury Terrace, Heaton, Newcastle-upon-Tyne	(E) Nov. 1901

E.

Edminston, Alex. R., Ivy Cottage, Highfield Road, Walton, near Liverpool	(E) Jan. 1898

F.

ELECTED.

Finlay, George, 27, Clayton Park Square, Newcastle-upon-Tyne... (E) Nov. 1902
Fitzgerald, Junr., Durham Walker, 1, Wood Terrace, Westoe, South Shields ... ... (S) Feb. 1901
Fletcher, Arthur C. ... ... (E) Mar. 1900
Fortune, Thomas C., 76, Falmouth Road, Heaton, Newcastle-upon-Tyne... ... ... (E) Jan. 1902
Fowler, A. J. D., 8, East Parade, Newcastle-upon-Tyne ... ... (E E) Mar. 1903

G.

Gibbons, Norman B. ... ... (E) Feb. 1901
Gibbs, Alfred Percy, 83, Goldhurst Terrace, South Hampstead, London, N.W. ... ... (E) Nov. 1901
Glahome, John W., 43, North Terrace, Wallsend-on-Tyne... ... (E) Nov. 1899
Grey, Robert Bertram, 15, Victoria Villas, W., Newcastle-upon-Tyne (E) Oct. 1900
Green, Fred. Wm., 4, Belle Grove Place, Newcastle-upon-Tyne ... (E) Jan. 1902
Grey, Alfred Wm., 40, Devonshire Place, Jesmond, Newcastle-upon-Tyne ... ... (E) Nov. 1901

H.

Hall, George, 7, Wellington Terrace, South Shields ... ... (E E) Mar. 1903
Harvey, Albert G., 17, Beauly Crescent, Tynemouth ... ... (E) Nov. 1901
Heck, John S., 10, Bristol Terrace, Newcastle-upon-Tyne ... ... (E) Dec. 1899
Heck, William D., 10, Bristol Terrace, Newcastle-upon-Tyne ... (E) Jan. 1902
Hedley, Ralph, Jun., 19, Belle Grove Terrace, Newcastle-upon-Tyne (E E) Dec. 1899
Holmes, Stephen, 15, Park Road, Jarrow-on-Tyne ... ... (S) Dec. 1901
Houston, Cambell, 39, Melville Street, Pollockshields, Glasgow ... (E) Nov. 1901
Hutchinson, Wm. G., Rock Lodge, Roker, Sunderland ... ... (S) May 1899

J.

James, Matthew C., Jun., 6, Park Terrace, Gateshead-on-Tyne ... (E E) May 1899
James, Wm. E., 6, Park Terrace, Gateshead-on-Tyne ... ... (S) May 1899
Jennings, Edward C., 4, The Crescent, Gateshead-on-Tyne ... (E) Nov. 1901
Jobling, Vivian, 12, Bellgrove West, Newcastle-upon-Tyne ... (E) Oct. 1898
Joicey, Edward James, 30, Bewick Road, Gateshead ... ... (E) April 1900
Jones, Edward, 59, Maple Street, Newcastle-on-Tyne ... ... (E E) Mar. 1903

K.

Kirk, Malcolm, 87, Gloucester Street, Newcastle-upon-Tyne ... (E E)
Knight, Robt. C., Elswick Shipyard Newcastle-upon-Tyne ... (S) Nov. 1901

L.

Lamb, Robert, 165, Park Road, Newcastle-upon-Tyne ... ... (E) Apr. 1903
Leitch, George A., 12, Fern Avenue, Newcastle-upon-Tyne ... (E) Jan. 1902
Leitch, John Shearer, 16, Wandsworth Road, Heaton, Newcastle-upon-Tyne ... ... (S) Mar. 1903
Little, Alvin, 39, Leazes Terrace, Newcastle-upon-Tyne ... ... (E) Mar. 1901
Little, John, High Street, Felling-on-Tyne ... ... (E) Feb. 1903

ELECTED.

Lovatt, John James, 15, Kingsley Place, Heaton, Newcastle-upon-Tyne ... ... (E) Jan. 1903
Lowrison, Wm. R., Drawing Office, Elswick Shipyard, Newcastle-upon-Tyne .. .. (S) Nov. 1901
Luhrs, H., 20, Laburnum Avenue, Wallsend-on-Tyne ... ... (E) Nov. 1899

M.

Mackley, John Robert, 97, Enfield Road, Elswick, Newcastle-upon-Tyne ... ... (E) Dec. 1902
Matheson, Ian Ross, The Clack, Hebburn-on-Tyne ... ... (S) Dec. 1902
McRae, Alexander, 60, Chillingham Road, N., Heaton, Newcastle-upon-Tyne ... ... (S) Mar. 1903
McWilliams, Edwin J., 10, Belgrave Terrace, Newcastle-upon-Tyne (E E) Mar. 1903
Milne, George Murray, 18, Kirton Park Terrace, Preston Road, North Shields ... ... (S) Feb. 1898
Morris, David, Haingwood Terrace, Bill Quay-upon-Tyne... ... (S) Dec. 1900

N.

Nash, Osborn B., 18, Wentworth Place, Newcastle-upon-Tyne ... (E E) Mar. 1903
Neill, John, 15, Salem Hill South, Sunderland ... ... (E) Nov. 1901
Nichol, Robert, 9, Abbey Street, Gateshead-on-Tyne ... ... (E) Feb. 1902
Nichols, George Henry, 30, Denmark Street, Gateshead-on-Tyne (E) Oct. 1900

O.

Ogilvie, William, 41, Woodbine Road, Gosforth, Newcastle-upon-Tyne ... ... (E E) Oct. 1902

P.

Phillips, Alexander, 15, Park Avenue, Wallsend-on-Tyne... ... (S) Dec. 1902
Potts, Arthur W., 9, Beaconsfield Terrace, Gateshead-on-Tyne .. (E) Oct. 1898
Potts, Joseph, 14, Moreland Street, West Hartlepool ... ... (E) Feb. 1898
Potts, John N., 10, Ashburton Crescent, Gosforth, Newcastle-upon-Tyne... ... ... (E) Dec. 1900
Pringle, R. A., 191, Beaconsfield Street, Newcastle-upon-Tyne ... (E E) Nov. 1901
Purvis, William B., 25, William Street, North Shields ... ... (E E) Mar. 1903

R.

Readhead, Stanley, Westoe Hall, South Shields ... ... (S) Dec. 1902
Richardson, Norman Shephard, 15, Wentworth Terrace, Newcastle-upon-Tyne ... ... (E) Mar. 1901
Robson, Geo., Jun., 9, Wellington Terrace, South Shields ... ... (E) Mar. 1899
Robson, George, 155, Princes Street, Ipswich ... ... (E) Nov 1901

ELECTED

S.

Samson, Robert D., 5, Hotspur Street, Tynemouth ... ... (E) Feb. 1902
Sanders, Harold W., 48, Cardigan Terrace, Heaton, Newcastle-upon-Tyne ... ... (E) Nov. 1901
Schaeffer, Paul P., 4, Woodbine Avenue, Gosforth, Newcastle-upon-Tyne ... ... (E) Feb. 1902
Sinclair, Wm. R., 1, Stratford Villas, Heaton, Newcastle-upon-Tyne ... ... (S) Nov. 1901
Slee, Herbert Teal, 37, Grosvenor Place, Newcastle-upon-Tyne ... (E) Jan. 1903
Smith, John E., 15, Eslington Terrace, Newcastle-upon-Tyne ... (E) Nov. 1897
Spittle, Henry Stuart, 20, Eskdale Terrace, Newcastle-upon-Tyne (E) Oct. 1900
Sprague, Cycil R., B.Sc., 21, Wentworth Place, Newcastle-upon-Tyne ... ... (E) Nov. 1899
Stagg, Albert E., 52, Dene View, Wallsend-on-Tyne ... ... (E) Nov. 1899
Stirzaker, Stanley C., 16, Grosvenor Place, Newcastle-upon-Tyne (E) Nov. 1901

T.

Taylor, Arthur T. ... ... (S) Dec. 1900
Temperley, Nicholas R., 4, Carlton Terrace, Low Fell, Gateshead on-Tyne ... ... (E E) Dec. 1898
Thompson, John, 43, Mayfair Road, West Jesmond, Newcastle-upon-Tyne ... ... (E E) Mar. 1903
Thornton, E. Fielding, 4, Simonside Terrace, Heaton, Newcastle-upon-Tyne ... ... (E) Dec. 1900
Tulip, Wilfred, Whinney Hill, Choppington, Morpeth, Northumberland ... ... (E) Mar. 1902

V.

Vick, Henry Hampton, 19, Fern Avenue, Jesmond, Newcastle-upon-Tyne ... ... (S) Jan. 1903

W.

Wardroper, Arthur K., Walker Vicarage, Walker-on-Tyne ... (E) Dec. 1901
Watson, John G. B., 5, Nesham Street, Newcastle-on-Tyne ... (S) Jan. 1902
Watson, Kenneth, 3, Rosella Place, North Shields ... ... (E) Mar. 1899
Waymouth, Norman, 3, Heaton Grove, Newcastle-upon-Tyne ... (E) Nov. 1901
Wilson, James Dare, Rose Cottage, Shotley Bridge, Co. Durham (E E) Mar. 1903
Wilson, William, "Lancefield," Kellfield Avenue, Low Fell, Gateshead-on-Tyne ... ... (E) Feb. 1902
Winstanley, P. G., 89, Greengate, Barrow-in-Furness ... ... (S) Oct. 1898
Woods, Arthur, 26, Water Street, Huddersfield, Yorkshire ... (E) Nov. 1900

THE NORTH-EAST COAST INSTITUTION

OF

ENGINEERS AND SHIPBUILDERS.

Constitution and Bye-Laws,

ADOPTED AT A GENERAL MEETING ON THE 4TH MARCH, 1885.

REVISED AT THE CLOSING BUSINESS MEETING HELD ON 4TH MAY, 1887.

RE-REVISED AT THE CLOSING BUSINESS MEETINGS HELD ON 9TH MAY, 1888, 13TH MAY, 1889, 11TH MAY, 1891, 14TH MAY, 1895, 13TH MAY, 1898, AND 22ND MAY, 1903.

CONSTITUTION.

I.—The NAME of the Association is "The North-East Coast Institution of Engineers and Shipbuilders." Name.

II.—The OBJECTS for which the Institution is established are :—The advancement of the science and practice of Engineering and Shipbuilding, and the interchange of ideas and information amongst its members, by means of meetings for the reading and discussion of papers relating thereto, and placing on record its transactions. Objects.

III.—The Institution shall consist of Honorary Members, Members, Associates, and Graduates.

IV.—HONORARY MEMBERS shall be such distinguished persons as the Council may elect. Honorary Members.

V.—MEMBERS shall be Principals or Principal Managers engaged in Engineering or Shipbuilding ; Civil, Military, or Mining Engineers, or Naval Architects ; whose subscription shall be Two Guineas per annum : and other persons engaged in the above professions ; whose subscription shall be One Guinea per annum. Members.

VI.—ASSOCIATES shall be such persons as are not strictly Engineers or Shipbuilders, but are connected with or interested in such pursuits, and are deemed by the Council to be eligible for Associate membership. Their subscription shall be One Guinea per annum. Associates.

Graduates.

VII.—GRADUATES may be persons under twenty-four years of age, engaged in study or employment to qualify themselves for any of the above professions. Their subscription shall be Half-a-Guinea per annum.

Life Members and Associates.

VIII.—Any MEMBER may become a LIFE MEMBER by a single payment of Twenty Guineas, or any ASSOCIATE may become a LIFE ASSOCIATE by a single payment of Ten Guineas. All such compositions shall be deemed to be capital moneys of the Institution.

Officers.

IX.—The COUNCIL of the Institution shall be elected from and by the Members, and shall consist of one President, the Past-Presidents, eighteen Vice-Presidents, fifteen Ordinary Members of Council, and an Honorary Treasurer.

Election of Officers. (See Bye-Law No. 11.)

X.—The President and Honorary Treasurer shall be elected annually. Three Vice-Presidents and five Ordinary Members of Council shall be elected annually. The retiring Vice-Presidents shall be those who have been in office for the longest period, and Ordinary Members of Council those who have served three years from their last election.

The President shall be eligible for re-election for a second year; should he be re-elected he shall retire at the conclusion of his second year of office, and shall not again be eligible until after an interval of one year.

The retiring Vice-Presidents shall be eligible for re-election. The retiring Ordinary Members of Council shall not be eligible for re-election to the same office until after an interval of one year, but shall be eligible for election to any other office.

The Honorary Treasurer shall be eligible for re-election annually, or for election to any other office.

Honorary Members' Privileges.

XI.—Honorary Members may attend all the General Meetings, they may read papers, take part in discussions, in voting, in moving and supporting resolutions, in presentation of notices of motion, or in requisitions for Special Meetings, and in the proposition of new members; they shall also receive copies of the Transactions.

Members' Privileges

XII.—Members shall have all the privileges of the Institution as enumerated in the foregoing paragraph, and shall be eligible for office.

Associates' Privileges

XIII.—Associates shall have all the privileges enumerated in paragraph XI. They shall be eligible for office as Ordinary Members of Council

XIV.—Graduates may attend all the General Meetings, they may read papers, take part in discussions, and support resolutions; they shall also receive copies of the Transactions, but shall not sign proposals for new members, vote, nor be eligible for office. Graduates' Privileges.

XV.—The General Meetings of the Institution shall be held during the months of October to May, inclusive, of each year. General Meetings.

NOTE.—When the word Member is initialled with a capital letter it signifies a member under paragraphs IV. and V., but when initialled with a small letter, it signifies a member of any class of the Institution membership.

BYE-LAWS.

MEMBERSHIP.

1.—Every candidate for admission as a Member, Associate, or Graduate shall be proposed and recommended according to the Form A in the Appendix, in which form the name, usual residence or the place of business, the qualification for, and proposed class of membership of the candidate shall be distinctly specified. Proposals for Graduates must give the date of, and age, last birthday. Candidates for Admission.

The form shall be signed by a Member or Associate of the Institution, as proposer, and by at least other three Members or Associates as supporters, certifying a personal knowledge of the candidate.

The proposal so made shall be submitted to the Council, when, if it be approved, the Chairman shall sign the approbation, which shall be inserted in the notice calling the next General Meeting, when the candidate shall be balloted for, and shall be accepted if three-fourths of the votes are favourable.

2.—Graduates desirous of becoming Members shall be proposed and recommended according to the Form B in the Appendix. Graduates becoming Members

The proposal so made shall be submitted to the Council, who shall agree to or reject it.

3.—The balloting for membership shall be conducted in the following manner:—Each member shall be supplied by post with a list of the names of the candidates, according to the Form C in the Appendix, and shall strike out the names of such candidates as he desires shall not be elected. These lists may be Balloting for Members.

returned to the Secretary by post, or may be deposited in the ballot-box by the voter in person on entering a meeting at which an election is to take place. · The ballot-box will be closed at ten minutes after the advertised time of meeting. The lists shall then be handed over to the Chairman, who shall appoint two Scrutineers to examine them, after which examination the Chairman shall inform the meeting of the result.

Candidates to receive Notice of Election.

4.—Notice of Election as a member shall be sent to the candidate within one week after his election, according to the Form D in the Appendix; but his name shall not be added to the list of Members, Associates, or Graduates of the Institution, until he shall have paid his first annual subscription.

Rejection of Candidates.

5.—In case of rejection of the candidate, no mention thereof shall be made in the minutes, nor shall any notice be given to the unsuccessful candidate.

Subscriptions payable in Advance.

6.—All subscriptions shall be payable in advance, and shall become due on the 1st of August each year. Any Member, Associate, or Graduate, wishing to retire from the Institution shall continue to be liable for his annual subscription until he shall have given formal notice of his retirement to the Secretary, which notice must be given on or before the 31st of August in each year. Application for membership may be made at any time during a Session, and the subscription shall cover the membership up to the 1st of August following.

Receipt of Subscription.

7.—On payment of each subscription the Secretary shall forward to the member an official receipt.

Questions of Privilege.

8.—On question of privilege.—Any person who may be unknown in the meeting shall only be able to claim the privilege in question on proving his membership for the current Session.

Arrears of Subscriptions.

9.—Any member whose subscription is one year in arrear shall be reported to the Council, who shall direct application to be made for it, according to Form E in the Appendix; and in the event of its continuing in arrear until the end of that Session after such application, the Council shall have the power, after remonstrance by letter, according to the Form F in the Appendix of declaring that the defaulter has ceased to be a member.

Power of Council to remove Name from List of members.

10.—The Council may refuse to continue to receive the subscriptions of any member who shall have wittingly acted in contravention of the Regulations of the Institution, or who shall,

in the opinion of the Council, have been guilty of such conduct as shall have rendered him unfit to continue his membership; and the Council may remove his name from the list of members: and such person shall thereupon cease to be a member of the Institution. Notice of such action of the Council shall be forwarded to the person in question, in accordance with the Form G in the Appendix. The reason for such action of the Council shall not be stated to the person expelled, without the sanction of the Council.

OFFICERS.

Election of Officers.

11.—The Annual Election of Officers shall be conducted in the following manner:—The Council shall meet in March or April, and shall arrange a list of nominations, in accordance with the Form H in the Appendix. It shall nominate new names in the place of the retiring Members, and the number of nominations shall be one in excess of the number required in each section of the Council. Such list shall be presented at the General Meeting immediately preceding the last General Meeting of the Session, and any Member present shall be at liberty to nominate additional Members. The list shall show who remain in office throughout the Council, and who are retiring. A copy of this ballot list shall be forwarded to each Member and Associate, together with a complete list of Members of Council, to be filled in, in accordance with the instructions printed in the ballot form, and to be returned to the Secretary to be opened in the presence of the Council, at a Council Meeting which shall be held in April or May, when the scrutiny and counting shall be carried out by the Council. Any Member in voting shall be at liberty to erase any name or names from the list and substitute the names of any other person or persons eligible for each respective office other than those already placed on the ballot list by the Council and Members of the Institution.

Any voting paper returning either more or less than one President, eighteen Vice-Presidents, one Honorary Treasurer, and fifteen Ordinary Members of Council, shall be disqualified for the section or sections in which such errors occur, and the votes shall be lost for the said section or sections. The votes given as President, to a Member who is not elected President, shall count to him as a Vice-President; the votes given as Vice-President, or Treasurer, to persons not so elected, shall count to

them as Ordinary Members of Council, unless they have just completed a term of office in such capacity.

The voting list shall not be sent to any Member and Associate whose subscriptions are more than one year in arrear; nor shall any such Member be nominated on the list. For this purpose, the Secretary shall prepare, previously to the meeting of Council, a list of those Members whose subscriptions are more than one year in arrears.

Ballot to be declared at May Meeting.

12.—The result of the ballot for Officers shall be declared at the Closing Business Meeting, to be held in May, at which meeting general business shall be transacted. At this meeting the newly-elected Officers, after being declared, shall enter into office; and this shall be the last meeting of the Session.

Power of Council to fill up Casual Vacancy.

13.—The Council shall have power to supply any casual vacancy within itself (including any casual vacancy in the office of President), which shall occur between one May Meeting and another; and the Officers so appointed shall retire when the persons whose places they fill would have retired. Vacancies not filled during the year shall be filled at the General Election.

GENERAL MEETINGS.

General Meetings.

14.—The Annual General Meeting shall take place in October, and the Closing Business Meeting in May; each of these meetings shall be held in Newcastle-upon-Tyne. The Ordinary Meetings shall take place in the second week in each following month during the Session, unless otherwise arranged by the Council, and at such hours and places as the Council may determine.

Notice of Meetings.

15.—Seven clear days' notice of every General Meeting, Ordinary or Special, specifying the nature of business to be transacted, shall be given to every member of the Institution.

Special General Meetings.

16.—A Special General Meeting may be convened at any time by the Council, and such meeting shall be convened by the Council whenever such is the declared wish of a General Meeting, or whenever a written requisition, signed by twenty members, specifying the object of the meeting, is left with the Secretary. If, for fourteen days after the delivery of such requisition, a meeting be not convened in accordance therewith, the requisitionists, or any twenty members of the Institution, may convene a Special Meeting in accordance with the requisition. The business discussed at such Special Meetings shall only be that indicated on the notice calling the meeting.

Quorum.

17.—Twenty Members shall constitute a quorum for the purpose of a meeting other than a Special Meeting. Thirty Members shall constitute a quorum for the purpose of a Special Meeting.

Chairman at Meetings.

18.—The President shall be chairman at every meeting, and in his absence, one of the Past-Presidents or one of the Vice-Presidents; or in the absence of these, an Ordinary Member of Council shall take the chair; or if no Member of Council be present and willing to take the chair, the meeting shall elect a Chairman.

Decisions of General Meetings.

19.—The decision of a General Meeting shall be ascertained by a show of hands; or, when five Members or Associates shall demand, or the Chairman may think it desirable, the decision shall be taken by ballot. The manner of counting the votes shall be at the discretion of the Chairman, and an entry in the minutes, signed by the Chairman, shall be deemed sufficient evidence of the decision of a General Meeting. In cases of equality of votes, the Chairman shall have a casting vote; otherwise he shall not vote.

Questions of a Personal Nature in General Meetings.

20.—Questions of a personal nature arising in a General Meeting, shall, if possible, be referred to the Council, otherwise the decision of the meeting shall be taken by ballot on a motion or amendment put to the meeting. The ballot shall be taken by the voters (being Members or Associates) writing "for" and "against" on a slip of paper. The slips shall be folded and collected, and then counted in the presence of the meeting, and the result announced by the Chairman. Should fewer than twenty votes be given, it shall be understood that the question is shelved, and the votes shall be destroyed without being opened.

Transactions of Business, General Meetings.

21.—At every General Meeting of the Institution, the Secretary shall first read the minutes of the preceding meeting, which, on approval, shall be signed by the Chairman; business arising out of these minutes shall then be transacted. The Secretary shall read any notices which may have to be brought before the meeting. Notices of motion may then be given, and other business of the Institution may be attended to; but when a paper is to be read, the foregoing business shall not be extended beyond half-an-hour after the advertised time for commencing the meeting. The paper or papers for the evening shall then be read and discussed.

Dissolving General Meeting.

22.—If within half-an-hour after the time fixed for holding General Meeting a quorum is not present, the meeting shall be

dissolved, and all matters which might, if a quorum had been present, have been done at the meeting so dissolved, may forthwith be done on behalf of the meeting, by the Council; except the reading or discussion of a paper, which shall not proceed in the absence of a quorum.

Adjourning a General Meeting.

23.—Any General Meeting of the Institution may be adjourned by a vote of the Members and Associates present if there be a quorum; if there be not a quorum, the case shall be met by the preceding paragraph.

Introduction of Friends.

24.—Each member shall have the privilege of introducing one friend to the General Meetings, whose name must be written in the Visitors' Book, together with that of the member introducing him; but if the introducing member be unable to attend the meeting, he may send the name of the visitor to the Secretary. During such portions of any of these meetings as may be devoted to any business connected with the management of the Institution, visitors may be requested by the Chairman to withdraw. This shall be done if five Members or Associates, or both, present request it.

COUNCIL MEETINGS.

Council Meetings.

25.—The Council shall meet before each General Meeting, or on other occasions when the President shall deem it necessary; being summoned in either case by circular, stating the time of meeting, and the business, so far as is known.

Convening Meeting for Expenditure of Funds.

No business involving expenditure of the funds of the Institution (except by way of payment of current accounts) shall be transacted at any Council Meeting, unless the circular gives six clear days' notice, and states the business.

Discussions of Personal Character.

All discussions of a personal character in the Council shall be considered and treated as being strictly confidential.

Regulation of Proceedings.

26.—The Council may regulate its own procedure, and delegate any of its powers and discretions to any one or more of its number.

Chairman and Quorum.

The President shall, *ex officio*, be chairman of all Council Meetings, and in his absence one of the Past-Presidents or one of the Vice-Presidents shall take the chair; or in the absence of these, one of the Ordinary Members of Council shall be elected to take the chair. Five members of Council, including the Chairman, shall form a quorum.

Sub-Committees.

In the appointment of Sub-Committees, the Council shall determine the number which shall form a quorum in each case,

and shall appoint a Chairman. These regulations shall not affect the Finance Committee.

Sub-Committees

27.—The Council may appoint Committees either from itself, or with the assistance of persons outside, for the purpose of transacting any special business, or of investigating specific objects connected with the work and interests of the Institution.

Sub-Committees.

28.—All Committees or Sub-Committees shall be appointed by the Council, and shall be subject to that body, and shall report to it. The Council shall act upon these reports or recommendations as it may think best. The President shall, *ex officio*, be a member of all Committees.

Communication to Council.

29.—Any member may by communication addressed to the Secretary petition the Council to lay before a General Meeting of the Institution the contents of any letter which shall in a short, concise, and clear manner draw the attention of the Institution to public matters of importance in connection with legislation proposed by any governing body in reference to the construction of ships, machinery, or the working of the same, so that members may by their scientific and practical knowledge demonstrate the soundness or otherwise of the proposed measure.

Invitation to Strangers.

30.—The Council may invite to General Meetings or to Council Meetings any person or persons whose presence and assistance it may desire, and strangers so invited shall be permitted to take part in the proceedings, but not to vote.

Secretary and Treasurer's Duties.

31.—The Secretary, who shall also act as Treasurer, shall be appointed by and act under the direction and control of the Council, and shall be paid such salary as the Council shall determine. He shall attend all meetings, Council and General, and shall take minutes of the proceedings, and enter them in proper books provided for the purpose. He shall write the correspondence of the Institution and Council, read minutes and notices at meetings, report discussions, and, if required by the Council, prepare papers for reading and publication, and read papers and communications at the meetings. He shall receive all payments due to the Institution, and shall bank the cash in hand whenever it amounts to ten pounds. The bank shall be determined by the Council and the banking account shall be in the names indicated in connection with the Finance Committee. He shall keep a cash account book, general and detail, which shall on all occasions be open to inspection by the Finance

Committee or by the Council. He shall keep a register of the names of members, so arranged as to distinguish all members whose subscriptions are in arrear. He shall also perform whatever other duties are indicated in the Bye-Laws of the Institution as appertaining to his department; and shall remain in office during the pleasure of the Council. He shall not vote on any resolution.

32.—The following Sub-Committees shall be appointed annually at the first meeting of the Council in each Session:—

Finance Committee.

(1) A Finance Committee, to consist of seven persons, viz.: one Past-President or Vice-President, who shall be Chairman; five Members of Council, and the Honorary Treasurer of the Institution; three of whom shall form a quorum. The Treasurer shall be empowered to pay all amounts due from the Institution which are under two pounds. All amounts of two pounds and upwards shall be paid by cheque, signed by the Chairman of the Finance Committee (or in his absence, by the President or a Past-President), the Secretary and the Honorary Treasurer.

Payment of Accounts.

Reading and Library Committees.

(2) A Reading Committee, to consist of six members of Council. No member who has served on this Committee for three years in succession shall be eligible for re-election until after an interval of one year. (3) A Library Committee, in accordance with Library Rules, Nos. 1 and 3. (4) A Graduates' Award Committee to consist of five members.

TRANSACTIONS.

Papers to be submitted to Council.

33.—All papers shall be forwarded to the Secretary at least five clear weeks before the proposed date of reading. The Secretary shall submit them for approval to the Council, and on their general approval they shall be handed to the Reading Sub-Committee, three of whom at least, shall read the paper through.

Reading Sub-Committee.

The Reading Sub-Committee shall be at liberty to strike out any parts which, in their opinion, ought not to be read. They may also make any suggestions to the author as to points which might with advantage be inserted or altered.

Synopsis of Papers.

A synopsis of the subject-matter of each paper shall be forwarded to the Secretary, by the writer, for insertion in the circular convening the meeting at which the paper is to be read.

Printing Transactions.

34.—The papers read, and the discussions on them, or such portions of them as the Council shall select, shall be printed for

distribution among the members, each of whom shall receive a copy. These Transactions shall be edited by the Secretary, in accordance with instructions of the Council, who shall have power to omit parts of discussion which may be foreign to the subject, or which it may be deemed undesirable to retain. Each paper shall bear the date on which it was read in General Meeting.

Copy of Papers supplied to members before reading, etc.

35.—Copies of papers to be read during any Session will be sent seven days before the date of reading to members who shall have applied to the Secretary for them, in writing, at the commencement of the Session. The discussion on a paper shall not be considered closed on the evening on which it is read, but shall be open for renewal at a subsequent meeting, prior to the reading of the paper set down for that date.

Proofs sent to members for Correction.

36.—The Secretary shall send to each speaker as soon as possible after a General Meeting a copy in manuscript of the speaker's own remarks for correction. This copy must be returned to the Secretary within four days. A printed proof will also be sent to each speaker for further revision; this must be returned to the Secretary within three days, otherwise it will be deemed correct, and printed off after receiving verbal corrections.

Liberty to Print Explanatory Notes.

37.—The Council shall be at liberty to print as Transactions, either with the papers and discussions or separately, explanatory notes, etc., communicated after the reading or discussing of a paper. Such communications must be approved by the Reading Committee, and shall bear the date on which they shall have been received by the Secretary.

Institution not responsible for statements.

38.—The Institution shall not be held responsible for the statements and opinions advanced in any of the papers which may be read, or in the discussions which may take place at the Meetings of the Institution.

Copies of Transactions to be sent to members.

39.—Twenty copies of each paper and discussion shall be presented to the author of the paper, for private use, and one copy shall be sent to each member. When a paper is prepared by two authors, fifteen copies shall be presented to each. Duplicate copies of parts of the Transactions mislaid or lost by members cannot be supplied to them, except as provided for in Bye-Law 42.

Transactions not supplied to members in Arrears.

40.—The Transactions shall not be supplied free to members whose subscriptions are unpaid.

Members not to receive Transactions till after First Payment.

41.—Any member elected at any time between the Annual General Meetings shall be entitled to copies of all the Transactions issued during the Session to which his first subscription applies; but not until the subscription has been paid.

Transactions the Property of the Institution.

42.—The Transactions of the Institution shall be the exclusive property of the Institution, and shall be published only by the authority of the Council. Additional copies of papers required by authors for their private use can only be procured from the Secretary, at prices fixed by the Council from time to time, and these copies must contain the whole of the discussion following the papers, and be bound in the usual cover, with the addition of the following words:—"By permission of the Council," and "Excerpt Minutes of Proceedings." Duplicate volumes and copies of parts of the Transactions, if in print, can also be obtained from the Secretary, and shall be sold only by him, in such manner and at such prices as the Council shall have fixed.

Rule of Discussion.

43.—During a discussion upon any paper, no person shall be at liberty to speak more than once (except by way of explanation), nor for a longer period than ten minutes.

ACCOUNTS, &c.

Accounts.

44.—The Council shall present the yearly accounts (up to the 31st of July preceding) at the Annual General Meeting in October of each year, after they have been audited by a professional Accountant, appointed by the members at the Closing Business Meeting in May.

Trustees.

45.—The capital, stock, and funds of the Institution shall be vested in the names of three Trustees, to be elected from time to time as vacancies occur by the members of the Institution at a General Meeting called for that purpose. All mortgages and other securities shall be taken in the names of such Trustees; and on any new appointment the funds shall vest in the newly-appointed Trustee or Trustees jointly with the continuing or remaining Trustee or Trustees.

Investment of Funds.

46.—The Finance Committee may, with the consent of the Council, invest in the names of the appointed Trustees of the Institution any moneys not immediately required for the purposes of the Institution, in or upon any approved securities.

ALTERATIONS TO CONSTITUTION AND BYE-LAWS.

47.—Alteration in or addition to the Constitution and Bye-Law may be made only by resolution of the Members at the

Closing Business Meeting in May, after notice of the proposed alteration or addition has been announced at the previous General Meeting.

The resolution may be modified by the Council meanwhile, should they so desire; but in this case it shall be read at the Closing Business Meeting in May in its original form before it is proposed in the amended form.

Such resolutions shall be stated in the notice calling the intervening Council Meeting, and also in the notice calling the Closing Business Meeting in May.

Vote by Proxy.

Any Member unable to be present at the meeting at which such alterations are to be considered, but who is nevertheless desirous of recording his opinion thereon, shall be allowed to vote by proxy, such proxies shall be in Form J in the Appendix, which may be had on application to the Secretary, and may be used by any Member present at the meeting on behalf of the absent Member, and counted by the Chairman as of equal value with votes given in the manner provided in Bye-Law 19.

THE GOLD MEDALS.

RULES.

(Revised at Council Meeting held on 15th April, 1901.)

1.—That papers read by members of the Council shall be eligible for the Gold Medals' Award.

2.—That the medals shall be awarded by the vote of the Council given at a meeting of the Council at which the business has been specially noted on the circular convening the meeting.

3.—That when the Council proceeds to award the medals, authors of papers who are members of the Council shall not be present nor vote at such Council meetings.

4.—If at the meeting convened the Council is unable to agree, or considers it desirable, the matter may be deferred for consideration at a future meeting.

5.—That the medals shall be awarded annually, provided the papers are, in the opinion of the Council, worthy of the award, but not otherwise. Papers by authors who have already received a gold medal shall not be eligible for a medal till after the expiration of six years from the date of the previous paper for which the medal was awarded.

APPENDIX TO BYE-LAWS.

FORM A. (BYE-LAW 1.)

Name (in full)
Profession or Occupation and where Employed
Address
being desirous of admission into the North-East Coast Institution of Engineers and Shipbuilders, we, the undersigned, propose and recommend that he shall become*
thereof. We know him to be†
and eligible for the proposed membership.

* A Member, Associate, or Graduate.

† A Principal, Manager, or Draughtsman, etc. See Articles V., VI., and VII. of Constitution.

	FROM PERSONAL KNOWLEDGE.	SECTION OF MEMBERSHIP.
Proposed by		
Supported by Three Members or Associates.		

Dated this day of

(*When a Graduate is proposed the age last birthday should be stated.*)

FORM B. (BYE-LAW 2.)

A. B. [Christian Name, Surname, Occupation, and Address in full] being at present a Graduate of the North-East Coast Institution of Engineers and Shipbuilders, and upwards of twenty-four years of age, and being desirous of becoming a Member of the said Institute, we, the undersigned [Members or Associates], recommend him, from *personal knowledge*, as a person eligible for the proposed Change of membership, because—

(*Here specify distinctly the Qualifications of the Candidate according to the spirit of the Rules of the Institution.*)

Signed _____ } Three [Members or Associates.]

Dated this day of 19

FORM C. (BYE-LAW 3.)

BALLOTING PAPER FOR MEMBERSHIP.

The Council having considered the recommendations for Membership of the following gentlemen, present them to be balloted for, viz.:—

Member, Associate, or Graduate.	Occupation.	Address.	Nominated by.	Supported by Three Members or Associates.

Strike out the names of such persons as you desire shall *not* be elected, and forward the list by post to the Secretary, or personally place it in the ballot-box at the Meeting.

FORM D. (BYE-LAW 4.)

Sir,—I am directed to inform you that on the day of you were elected a of the North-East Coast Institution of Engineers and Shipbuilders, but, in conformity with Bye-Law 4, your election cannot be confirmed, nor your name be added to the roll of membership, until you have paid your first annual subscription, the amount of which is £ : : , or, at your option, the Life Composition of £ : : .

Payment may be made to the Treasurer, Mr._____

Address_____

I am, Sir,

Yours faithfully,

Secretary.

Dated 19

N.B.—In case of a Graduate, strike out "*or, at your option, the Life Composition of £ : :* "

FORM E. (BYE-LAW 9.)

SIR,—I am directed by the Council of the North-East Coast Institution of Engineers and Shipbuilders to draw your attention to Bye-Law 6, and to remind you that the sum of £ of your annual subscriptions remains unpaid, and that you are in consequence in arrear of subscription.

I am also directed to request that you will cause the same to be paid without further delay, otherwise the Council will be under the necessity of exercising their discretion as to using the power vested in them by the Rule above referred to.

I am, Sir,

Yours faithfully,

Secretary.

FORM F. (BYE-LAW 9.)

SIR,—I am directed by the Council of the North-East Coast Institution of Engineers and Shipbuilders to inform you that in consequence of non-payment of your arrears of subscription, and in pursuance of Bye-Law 9, the Council have determined that unless payment of the amount (£) is made previous to the day of next, they will proceed to declare that you have ceased to be a member of the Institution.

But, notwithstanding this declaration, you will remain liable for payment of the arrears due from you.

I am, Sir,

Yours faithfully,

Secretary.

FORM G. (BYE-LAW 10.)

SIR,—I am directed by the Council of the North-East Coast Institution of Engineers and Shipbuilders to inform you that they feel it their duty to advise you to withdraw from the Institution, or otherwise they will be obliged to act in accordance with Bye-Law 9 (or 10, as the case may be).

I am, Sir,

Yours faithfully,

Secretary.

FORM H. (BYE-LAW 11.)

BALLOTING LIST.

PRESIDENT.—ONE NAME only to be returned, or the vote will be lost.

——— President for the current year (eligible for re-election.)*

——— } New Nominations, from whom to select ONE.

VICE-PRESIDENTS.—EIGHTEEN NAMES only to be returned (including the fifteen who remain in office), or the vote will be lost.

——— } Fifteen Vice-Presidents remaining in office. These do not require to be voted for at this election, as their term of service has NOT yet expired.

——— } Three Vice-Presidents retiring, eligible for re-election.

——— } New Nominations, from whom to select THREE.

TREASURER.—ONE NAME only to be returned, or the vote will be lost.

——— Treasurer for the current year, eligible for re-election.

——— } New Nominations, from whom to select ONE.

ORDINARY MEMBERS OF COUNCIL.—FIFTEEN NAMES only to be returned, including the ten who remain in office.

——— } Ten Ordinary Members Council remaining in office. These do not require to be voted for at this election, as their term of service has NOT yet expired.

——— } Five Ordinary Members of Council retiring, and NOT eligible for re-election.

——— } New Nominations, from whom to select FIVE.

* To be crossed out before issue when the President is not eligible for re-election.

N.B.—(*a*) The names of those who remain in office will be counted in the total number required without being re-written by the voter.

(*b*) Any list having either MORE or LESS than the required number of names voted for in any section will be disqualified for that section.

(*c*) Votes as President for a person who is not elected will count for him as a Vice-President.

(*d*) Votes as Vice-President, or Treasurer, for persons not so elected, will count for them as Ordinary Members of Council, unless they have just completed a term of office in that capacity.

(*e*) This list, duly filled in, may be returned to the Secretary by post, or handed to him, so as to be on the Council table before the commencement of the scrutiny, which is appointed to take place in the Council Room, at 8 p.m., on 19

(*f*) A copy of this list shall be posted at least Seven Days previous to the Annual Meeting to every Member and Associate, who may erase any name or names from the list and substitute the name or names of any other person or persons eligible for such respective offices, but the number of persons on the list after such erasure or substitution must not exceed the number to be elected to the respective offices.

Secretary.

FORM J. (BYE-LAW 45.)

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.

FORM OF PROXY.

FOR VOTES ON ALTERATIONS TO CONSTITUTION OR BYE-LAWS.

I,....., being [an Honorary Member, Member, or Associate] of the above Institution, do hereby appcint Mr..... who is [an Honorary Member, Member, or Associate] of the same Institution, to act as my Proxy, and record my Vote at the General Meeting of the Institution, to be held on the... .....day of ....., 18....., and at any adjournment thereof.

Signature.....

Address.....

.....

.....*Secretary.*

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.

Supplementary Bye-Laws Relating to the Graduate Section.

I.—The Graduate Section shall be controlled by the General Bye-Laws of the Institution, and the following Bye-Laws are supplementary to these.

This Section shall be open to all members of the Institution who are under twenty-six years of age, who shall be at liberty to express their views upon any subject brought before the General Meetings of the Section.

Officers by Ballot.

II.—The Officers of the Section shall be elected from and by the Graduates, in accordance with the Form given in the Appendix, and shall consist of one Chairman, one Honorary Secretary, and seven Committee-men. The Committee shall have power to select one of its members to act as Assistant Honorary Secretary if required.

Election of Officers.

III.—(*a*) The Officers shall be elected annually, and shall all be eligible for re-election until the age limit is reached.

Rider to General Bye-Law No. 11.

(*b*) Any voting paper returning either more or less than one Chairman, one Honorary Secretary, and seven Committee-men shall be disqualified.

General Meetings.

IV.—The Annual General Meeting shall take place as early as possible after that of the Institution in the month of October, and the Closing Meeting shall be held prior to the Closing Business Meeting of the Institution in May.

Special General Meetings.

V.—A Special General Meeting may be convened at any time by the Committee. The business discussed at such Special Meetings shall only be that indicated on the notice calling the meeting.

Quorum.

VI.—Nine members shall constitute a quorum for the purpose of a General Meeting.

Excursions.

VII.—Excursions shall be arranged during the Session as the Committee may find expedient. Any Graduate wishing to introduce a friend at such excursions must submit the name of his friend to the Committee at least three clear days before the date of the excursion.

Seven clear days' notice of every excursion shall be given to every member of the Graduate Section.

COMMITTEE MEETINGS.

Committee Meetings.

VIII.—The Committee shall meet at as early a date as possible after the holding of a General Meeting, and on other occasions when the Chairman shall deem it necessary, being summoned in either case by circular, stating the time of meeting and the business so far as is known. All discussions of a personal character in the Committee shall be considered and treated as being strictly confidential.

Four members of Committee, including the Chairman, shall form a quorum.

Duties of Hon. Secretary.

IX.—The Honorary Secretary shall act under the direction and control of the Committee. He shall attend all Meetings, Committee and General, and shall take minutes of the proceedings and enter them in proper books provided for the purpose. He shall write the correspondence of the Graduate Section and Committee (excepting that arranging for excursions, which shall be arranged by the Secretary of the Institution). He shall keep a stamp account book, which on all occasions shall be open to the inspection of the Secretary of the Institution.

PAPERS.

Synopsis of Papers to be read.

X.—The author of a paper shall forward to the Honorary Secretary, at least fourteen days before the date of the reading of the paper, its title and a synopsis of the contents; a copy of the synopsis to be forwarded to every Graduate, together with the notice convening the meeting at which the paper is to be read.

Copies of Papers to be forwarded to the Secretary of the Institution.

XI.—Each Paper read before the Section should not exceed ten octavo pages of letterpress, and the illustrations not greater in extent than will cover two quarto plates. All manuscripts to be written on one side of the paper only, and to be signed by the author. The date on which the paper was read must be inserted after its title.

All papers submitted to the Graduate Award Committee shall be placed in the hands of the Secretary of the Institution not later than the 31st of May in each year.

Of these papers submitted to the Graduate Award Committee, either one or two may be recommended to be printed as an Appendix to the current volume of the Transactions of the Institution, the Council reserving the right to decline to give any award or to print any of the papers should it consider the standard insufficient.

The submission of any paper for an award, and its publication prior to its submission, is entirely at the option of the author of such paper, but if it be published without the sanction of the Council, it shall be ineligible for competing in the Award Competition, and no reference must be made to its having been read before the Graduate Section of the Institution.

All papers submitted for awards shall become the property of the Institution, and if published in the Technical Journals the permission of the Council must be previously obtained and the name of the Institution must be attached.

APPENDIX.

GRADUATES' BALLOTING LIST.

CHAIRMAN.

*———— (E)
———— ( ) } Nominations from whom to select ONE.

HON. SECRETARY.

*———— (E)
———— ( ) } Nominations from whom to select ONE.

COMMITTEE.

*———— (S)
*———— (EE)
*———— ( )
———— ( )
———— ( )
———— ( ) } Nominations from whom to select FIVE.

NOTES.

1.—Any list having either more or less than the required number of names will be disqualified.

2.—All voting papers must be returned to the Secretary of the Institution on or before the day of , 19 .

3.—No signature must be put on this paper.

4.—* Signifies a member of the old committee.

5.—(E) Denotes Engineer; (EE) Electrical Engineer; (S) Shipbuilder.

6.—A copy of this list shall be posted, at least fourteen days previous to the Closing Meeting of the Session, to every Graduate, who may erase any name or names from the list and substitute the name or names of any other person or persons eligible for such respective offices, but the number of persons on the list after such erasure or substitution must not exceed the number to be elected to the respective offices.

7.—Votes as Chairman or Hon. Secretary, for persons not so elected, will count for them as members of committee.

THE LIBRARY AND READING ROOM RULES.

Committee.

1.—The Library and Reading Room shall be managed by a Committee, called the Library Committee, who shall have charge of all books, papers, specimens, etc., which may belong to the Institution. It shall consist of five members of the Institution, of whom at least two shall be members of Council.

Property.

2.—The books and other property of the Library shall be vested in the Trustees appointed by the Institution.

Appointment of Committee.

3.—The Library Committee shall be appointed annually, at the first meeting of the Council in each Session. No member who has served on the Committee for three years in succession shall be eligible for re-election until after an interval of one year. The Chairman shall be elected by the Council.

Librarian.

4.—The Secretary of the Institution shall be Librarian, and shall also act as Secretary to the Library Committee. Three members of the Committee shall form a quorum.

Duties of Committee.

5.—The Library Committee shall be responsible for the binding and purchasing of books, periodicals, papers, etc., and for the expending of all money voted by the Council for its use. It shall appoint an attendant who shall act as Assistant Librarian. It shall make Rules for the management of the Library, subject to the approval of the Council, and present an annual report to the first meeting of the Council held after the annual scrutiny of the books referred to in Rule No. 13.

Hours of Opening and Closing, etc.

6.—Except when closed by special order of the Library Committee, or when the Council is sitting, the Library and Reading Room shall be open for consulting, borrowing, or returning books, every week day as follows:—

FROM OCTOBER 1ST TO MAY 31ST.

Monday ... Tuesday ... Wednesday ... Friday ...	From 10 a.m. to 8 p.m.
Thursday ...	From 10 a.m. to 1 p.m.
Saturday ...	From 10 a.m. to 1 p.m. and from 3 p.m. to 9 p.m.

FROM JUNE 1ST TO SEPTEMBER 30TH.

Monday ... Tuesday ... Friday ...	From 10 a.m. to 5 p.m
Wednesday ...	From 10 a.m. to 8 p.m.
Thursday ...	From 10 a.m. to 1 p.m.
Saturday ...	From 10 a.m. to 1 p.m. and from 6 p.m. to 9 p.m.

The Rooms will be closed on Christmas Day and the day following; New Year's Day and the day following; Good Friday and the day following; Monday and Tuesday in Easter week and Whit week; on Tuesday, Wednesday, Thursday, Friday and Saturday in the Race week of June; and from the fourth Saturday in July to the second Saturday in August inclusive, as mentioned in Rule No. 13.

Lending of Books.

7.—Books shall not be lent to any persons except Members, Associates, or Graduates of the Institution, but a person entitled to borrow a book may send a messenger with a signed order for it.

Visitors.

8.—Each member shall be entitled to introduce a friend to the Reading Room, whose name shall be written in the Visitors' Book, together with that of the member introducing him.

Reference Books.

9.—The books marked with an asterisk in the Catalogue shall be kept only for consultation in the Library, and shall not be lent. Pending the preparation of a Catalogue, the Librarian shall be instructed by the Committee as to which books shall be withheld from circulation.

Unbound Books.

No periodicals, magazines, or pamphlets shall be issued for circulation until after they have been bound and added to the Lending Library.

Register of Books Lent, etc.

10.—The Librarian shall keep a register in which he himself or the attendant shall enter the titles of the books lent, the date of lending, the name of the borrower, and the date of the return of the book to the Library. The borrower of the book or the bearer of his order shall initial the entry of such borrowing, and the Librarian or the attendant shall initial the date of the return of the book.

Number Lent to each member.

11.—No person shall borrow or have in his possession at one time more than two volumes belonging to the Library.

Return of Book.

12.—No member shall retain a book longer than fourteen days, excluding the day of issue. He shall be responsible for the safe return of the book, and if it be damaged or lost he shall make good the cost of such damage or loss.

Yearly Inspection of Books.

13.—All books belonging to the Library shall be called in for inspection, and the lending out of books shall be suspended from the fourth Saturday in July to the second Saturday in August inclusive, in each year, and members shall be required by notice to return all books in their hands before the period mentioned.

Fine

Members failing to comply with this injunction shall pay a fine of two shillings and sixpence.

14.—Members are requested, when in the Reading Room or Library, to contribute to the general comfort by carefully abstaining from loud talking and noise of any kind. Smoking is not permitted in the Library.

Members in Arrears.

15.—Any member being twelve months in arrears with his subscription to the Institution shall not be at liberty to use the Library or Reading Room after the commencement of the first Session following.

N.B.—The foregoing Rules may be amended at any time by the Library Committee with the sanction of the Council.

NORTH-EAST COAST INSTITUTION

OF

ENGINEERS AND SHIPBUILDERS.

NINETEENTH SESSION, 1902-1903.

PROCEEDINGS.

NINETEENTH ANNUAL MEETING, HELD IN THE LECTURE THEATRE OF THE LITERARY AND PHILOSOPHICAL SOCIETY, WEST-GATE ROAD, NEWCASTLE-UPON-TYNE, ON FRIDAY EVENING OCTOBER 24TH, 1902.

JOHN TWEEDY, ESQ., J.P., PRESIDENT, IN THE CHAIR.

The SECRETARY read the minutes of the Closing Business Meeting of last Session, which were confirmed by the members present and signed by the President.

The PRESIDENT appointed Mr. W. H. Dugdale and Mr. G. W. Sivewright to examine the ballot papers for new members, and the following gentlemen were declared elected:—

MEMBERS.

Adam, James, Engineer Draughtsman, 9, Ibrox Place, Whitfield Road, Govan Glasgow.

Adamson, Henry, Superintendent Engineer, 3, Devonshire Place, Newcastle-upon-Tyne.

Allan, Percival, Engineer, Wansbeck Street, Jarrow-on-Tyne.

Barber, Wm. Daglish, Ship Draughtsman, 69, Elswick Rd., Newcastle-upon-Tyne.

Black, Charles, Engineer, c/o Messrs. Vacuum Oil Co., Ltd., 7, Side, Newcastle-upon-Tyne.

Carney, W. H., Shipbuilder, c/o Messrs. Port Talbot Graving Dock, Port Talbot.

Fairweather, C. W., Engineer, c/o Messrs. Northern Counties Electricity Supply Co., Ltd., 13, Mosley Street, Newcastle-upon-Tyne.

Ferry, S., Engineer, 10, Malvern St., Newcastle-upon-Tyne.

Gunter, John Henry, Works Manager, c/o Messrs. Dorman, Long & Co., Ltd. Britannia Steel Works, Middlesbrough.

Hayashida, N., Marine Engineer, c/o Mitsubishi Dockyard and Engine Works, Nagasaki, Japan.

Henderson, J. R., Lloyd's Surveyor, 3, Humbledon View, Sunderland.
Kelly, A. Wardle, Engineer, 94, Kingsley Terrace, Newcastle-upon-Tyne.
Kerr, Robert, Superintendent Engineer, Bank Chambers, Mosley Street, Newcastle-upon-Tyne.
Lees, Charles, Superintendent Engineer, c/o Messrs. Elder, Dempster & Co., Ltd., Avonmouth, near Bristol.
Martin, William, Mechanical Engineer, 69, Hotspur Street, Heaton, Newcastle-upon-Tyne.
Murray, Councillor W., Engineer, 30, Simonside Terrace, Newcastle-upon-Tyne.
Oxley, Alfred, Civil Engineer, Lamesley, County Durham.
Reilly, Myles O'Hara, Shipbuilder, 13, Woodlands Terrace, Borough Road, Middlesbrough.
Riley, John, Boilermaker, 1, Spring Street, Stockton-on-Tees.
Skentlebury, G. Arthur, Shipbuilder, 22, Lansdowne Terrace, Gosforth, Newcastle-upon-Tyne.
Stirling, John F., Forgeman, Gilliat House, North Road, Darlington.

GRADUATES TO MEMBERS.

Bertram, N. Stewart, Engineer, c/o Messrs. Lillishall & Co., Oakingates, Shropshire.
Fitzgerald, Arthur F., Engineer, 1, Wood Terrace, South Shields.
Mudd, Percival Arthur, Engineer, Greencliffe, Hartlepool.
Nixon, John R., Shipbuilder, c/o Messrs. Blyth Shipbuilding Co., Ltd., Blyth.

ASSOCIATES.

Gaunt, Richard, Contractor, Albany Villa, Eaglecliffe, R.S.O.
Tomkins, Harry, Contractor, 3, Lorne Terrace, Stockton-on-Tees.

GRADUATE.

Ogilvie, William, Electrical Engineer, 41, Woodbine Road, Gosforth, Newcastle-upon-Tyne.

LETTER FROM MR. WILLIAM BOYD.

The SECRETARY read a letter received by the President from Mr. Boyd, the First President of the Institution, expressing his regret at his unavoidable absence that evening and wishing the President every success and prosperity during his occupation of the Chair.

The SECRETARY said—With regard to this letter I may say that Mr. Boyd has always made it a rule (and I do not think he has missed once) to attend the annual meetings and give his support to the new Presidents in the chair; and he has also considered it his duty to propose the vote of thanks to each President for his address.

The SECRETARY read the Eighteenth Annual Report and submitted the Balance Sheet.

The PRESIDENT (Mr. John Tweedy) delivered his Inaugural Address.

COUNCIL REPORT.

(Eighteenth Session, 1901-1902.)

The Eighteenth Session of the Institution was opened with a conversazione and ball at the kind invitation of the President (Henry Withy, Esq., J.P.) and Mrs. Withy, held in Newcastle-upon-Tyne on Friday evening, October 25th, 1901.

During the Session the following papers were read and discussed:—

"The Speed of Machine Shop Tools." By Mr. J. W. E. Littledale.
"The Ballasting of Modern Tramp Steamers." By Mr. E. C. Chaston.
"Some Notes on Steam Turbines." By Mr. F. J. Warburton.
"Report on Memorandum submitted to the First Lord of the Admiralty, on the 16th of July, 1901, with reference to the unsatisfactory condition of the Engineering Branch of H.M. Navy." By Mr. D. B. Morison.
"On Passenger Accommodation in Steamships." By Mr. M. C. James.
"Workshop Records." By Mr. George Parker.
"Co-Operation and Mechanical Aids to Workshop Cost-Keeping." By Mr. R. P. Link.

The paper by Mr. D. B. Morison, on the "Unsatisfactory condition of the Engineering Branch of H.M. Navy," drew forth a lengthy and interesting discussion.

No gold medal was awarded for shipbuilding papers read during the seventeenth session. The engineering gold medal was awarded to Mr. Edwin Griffith for his paper on "Water-Tube Boilers."

The annual dinner was held in Newcastle-upon-Tyne on Thursday, January 30th, 1902, and was well attended by members and friends.

Mr. Robert Thompson, Past-President, having been obliged to resign his seat as one of the representatives of the North-East Coast District on Lloyd's Technical Sub-Committee on account of him being elected a member of Lloyd's General Committee, the Council elected Mr. W. H. Dugdale, Vice-President, to fill his place.

In reply to a letter received from The Institution of Civil Engineers' Committee on "Standard Sections," inviting the Council to nominate a member of our Institution to represent the N.E. Coast district on this Committee, Mr. Henry Withy, Past-President, was unanimously elected by the Council. A further communication having been received asking the Council to nominate an Engineer to act on the "Engineering Standards Committee," Mr. Summers Hunter was also elected by the Council to represent this district.

The Council regrets that Mr. John Gravell, who for a period of ten years has represented this Institution on the Council of the Durham College of Science has found it necessary to withdraw. The Council has thought fit to pass a resolution that for the future the Institution shall be represented on the Council of the College by its President.

The following is an extract from the report submitted by Mr. Gravell to the Council:—

To the President and Council of the North-East Coast Institution of Engineers and Shipbuilders, Newcastle-upon-Tyne.

The Durham College of Science,
Newcastle-upon-Tyne.

During the past five years several important developments have taken place in the work of the College.

No branches of applied science have recently made more marked progress than Electricity and Engineering. These departments have accordingly been strengthened by the foundation of a Lectureship in Electrical Engineering and of a Demonstratorship in Engineering.

The work of the former has been eminently successful and has proved highly beneficial to the district—more especially so in the case of the evening students. The demand for tuition in the laboratory has been so great during the current session—no fewer than 66 students having been in attendance—that they have been compelled to devote an additional evening per week to meet their requirements. The lecture classes have been attended by upwards of one hundred and fifty students.

The number of students attending the classes in Mechanical, Civil and Marine Engineering has been steadily rising, and it is gratifying to report that, owing to the interest taken by the County Councils of Northumberland and Durham in the work done at the College, they have recently been able to appoint a temporary Assistant to the Professor of Engineering to assist in conducting special experiments on the Experimental Engines, and it is hoped that the results of these experiments will prove very valuable to the Engineering world.

The thorough efficiency of the work in every department of the College is satisfactorily maintained. It must, however, be admitted that it is hampered for want of room and by deficient accommodation. The College would render better service to the district if its front were completed and every department reasonably equipped.

In October, 1899, a Public Meeting was held under the Presidency of Earl Grey, Lord Lieutenant of Northumberland, at which warm sympathy was expressed with the work of the College. The result of the meeting was that the New Building Completion Fund was started, and up to the present the subscriptions have amounted to over £31,000.

After Lord Armstrong's death in 1900, it was felt that his brilliant and beneficial life should be worthily commemorated, and it was suggested that a very suitable memorial would be to erect a statue and to dedicate the College to his memory. These proposals were warmly approved by Dr. Watson-Armstrong, and cordially accepted by the College Council, and the University consented to the change of name on condition that the Armstrong Memorial Fund reached a total of not less than £50,000. The response to this appeal has so far resulted in £26,000 having been received or promised, and a generous benefactor has offered £10,000 on condition that the fund reaches £50,000 (inclusive of his own gift) by the end of the current year. Strenuous efforts are being made to enable them to accept this munificent offer.

As usual the staff has been greatly sought after by other institutions. Mr. R. M. Ferrier, M.Sc., who since 1891 had held the post of Lecturer in Engineering, was in September last appointed Professor of Engineering at University College, Bristol; and at the beginning of the year Mr. J. W. Hayward, M.Sc., who was the Demonstrator in Engineering, received an appointment under Professor Unwin at the Royal College of Science, South Kensington.

The majority also of the students obtain important positions upon the completion of their college careers, and many of them specially distinguish themselves.

In submitting this Report to the Council, I take the opportunity of thanking them for the honour they have done me in appointing me their Representative for the last ten years. I also beg to thank the Principal of the Durham College for the kindness and courtesy which he has shown me at all times, and more especially for his assistance in drawing up this Report.

In conclusion, I would request that the most favourable notice be taken by the Council and Members of our Institution of the benefits which the College can supply, and beg them to give this important medium of high education their most earty support.

JOHN GRAVELL.

June 16th, 1902.

Appended is a diagram (Plate I.) furnished by Prof. Weighton, which shows the progress in the numbers attending classes in the Departments of Engineering and Naval Architecture since their foundation in the year 1891. It will be noticed from this diagram that there has been a steady increase, especially in the day classes, which means those taking a regular course of study, generally with a view to a Degree. It should further be mentioned, as showing the relative importance attained by Engineering in the College, that last year those going forward to a Degree in Engineering and Naval Architecture, were just equal in number to those students similarly going forward for the whole of the other departments of the College taken together. This shows that extremely satisfactory progress is being made in the systematic study of engineering and shipbuilding.

The thanks of the Institution are due to Mr. Gravell for his great zeal and energy displayed while acting as the representative of this Institution.

In reply to an invitation received from the Durham College of Science the Council elected Mr. Henry Withy, Past-President, and Mr. George Clark, Member of Council, to represent this Institution on the "Committee appointed to consider what provision should be made for further and higher metallurgical teaching in the north of England."

Messrs. Charles Cammell & Co., having invited the members of the Institution to view their establishment in Sheffield, arrangements were made to visit the works on Wednesday, July 16th, 1902. About 200 members availed themselves of the trip. They were conducted over the Grimesthorpe and Cyclops works and were afterwards entertained to dinner by the firm. A most enjoyable day was spent and the visit proved most interesting and instructive. The thanks of the Institution are due to Messrs. Cammell & Co. for their kindness.

The financial statement for the year ending July 31st, 1902, is appended to this report. A further sum of £300 has been invested on mortgage of the Tyne Consolidated Fund at 3½ per cent. per annum for a period of fifteen years. The Council regrets having to state that after having written off the sum of £17 6s. 6d. as irrecoverable, the subscriptions in arrears still amounts to £93 19s. 6d.

During the year the following additions have been made to the roll of members:—Members, 54; Associates, 21; Graduates, 40; and 32 Graduates have been passed into the Members' section. Mr. F. C. Marshall, Past-President, having resigned his membership on account of ill-health, the Council, in recognition of the great services rendered by Mr. Marshall to the Institution in its earlier years, has thought fit to appoint him a Life Member of the Institution. The Council has also elected the Right Hon. The Earl of Glasgow, President of the Institution of Naval Architects, an Honorary Member of this Institution.

The Council regrets having to record the loss by death of the following:—Members: Mr. William Graham, Mr. R. C. Hamilton, Mr. G. Rutherford, Mr. Eustace Smith, Mr. R. P. Torrance, and Mr. W. C. Wright. Associate: Mr. W. H. Scott.

The Institution has also lost by resignations and other causes: 34 Members, 10 Associates and 19 Graduates.

The total number of names now enrolled is as follows:—

Honorary Members	4
Life Members	9
Members	888
Life Associates	3
Associates	150
Graduates	109
	1,163

GRADUATE SECTION.

During the thirteenth session of the Graduate section nine meetings were held. The average attendance showed a substantial increase over that of former years.

At the opening meeting the Chairman, Mr. J. B. Donaldson, gave his address, the subject being "An Analysis of Trial Trip Data," and during the session the following papers were read and discussed.

"The Air Vacuum Brake." By Mr. Andrew Cruickshank.
"The Marine Water Tube Boiler." By Mr. W. L. Wotherspoon.
"Oil Tank Steamers." By Mr. H. Böcler.
"Superheated Steam and Superheaters." By Mr. R. Robson.
"The Westinghouse Brake." By Mr. J. D. Andrew.
"The Auxiliary Machinery of Ships." By Mr. A. W. Bowerbank.
"Application of Electric Power to the Driving of Factories." By Mr. N. R. Temperley.

The following places of interest were visited:—

The Northumberland Engine Works of Messrs. The North-Eastern Marine Engineering Company, Wallsend-on-Tyne; Messrs. John Dickinson & Company, Palmers Hill Engine Works, Sunderland.

The thanks of the Institution are due to the principals and officials of these establishments for the kindness and courtesy extended to the junior members. Also to Mr. F. Caws for the use of his rooms in Sunderland on the occasion of the graduates' visit to that town.

The following awards were presented to the authors of papers read before this section during the twelfth session:—

Books, etc., to the value of £3, to Mr. George Nelson, for his paper on "The Design of Large Thrust-Blocks."
Books, etc., to the value of £2 10s. to Mr. R. Robson, for his paper on "The Wiring of Ships for Electrical Installation."
Books, etc., to the value of £2 to Mr. H. B. Donaldson, for his paper on "The Construction of a Modern Merchant Steamer."

Mr. George Nelson was elected Chairman and Mr. J. S. Heck Honorary Secretary of this section for the current year.

NORTH-EAST COAST INSTITUTION OF

STATEMENT OF RECEIPTS AND PAYMENTS

Receipts.

To Balance from last Account—										£	s.	d.	£	s.	d.
At Bank	...	...	...	...	...	...	...						449	5	0
„ Subscriptions received for Session 1901-1902—															
252 Members at £2 2s.	...	...	...					£529	4	0					
569 Members „ £1 1s.	...	...	...					597	9	0					
147 Associates „ £1 1s.	...	...	...					154	7	0					
106 Graduates „ 10s. 6d.	...	...	...					55	13	0					
1,074											1,336	13	0		
„ Association of Foremen Engineers and Draughtsmen—															
One year's Subscription	...	...	...	...	...						20	0	0		
„ Subscriptions received in advance	...	...	...	...							3	3	0		
„ Arrears from Session 1900-1901—															
9 Members at £2 2s.	...	...	...					£18	18	0					
12 Members „ £1 1s.	...	...	...					12	12	0					
											31	10	0		
														1,391	6	0
„ Transactions sold this Session	...	...	...	...							16	5	8		
„ Copies of Members' Papers supplied	...	...	...								35	0	0		
														51	5	8
„ Tyne Improvement Commissioners—															
One Year's Interest to 21st June, 1902, on £605, at 3½ per cent.	...	...	...	...	...	...	...				21	3	6		
Viz.:—Medal Fund	...	...	...					£274	0	0					
Graduates' Award and Life Members' Fund	...	...						331	0	0					
Less—Tax	...	...	...	...	...	...					1	5	1		
														19	18	5
One Year's Interest to 10th July, 1902, on £500, at 3½ per cent.	...	...	...	...	...	...	...				18	15	0		
Less—Tax	...	...	...	...	...	...	...				1	2	4		
														17	12	8
One Year's Interest to 4th May, 1902, on £300, at 3 per cent.	...	...	...	...	...	...	...				9	0	0		
Less—Tax	...	...	...	...	...	...	...				0	10	6		
														8	9	6
One Year's Interest to 13th July, 1902, on £300, at 3½ per cent.	...	...	...	...	...	...	...				9	15	0		
Less—Tax	...	...	...	...	...	...	...				0	11	8		
														9	3	4
One Year's Interest to 9th June, 1902, on £300, at 3½ per cent.	...	...	...	...	...	...	...				9	15	0		
Less—Tax	...	...	...	...	...	...	...				0	11	6		
														9	3	6
Half Year's Interest to 8th May, 1902, on £300, at 3½ per cent.	...	...	...	...	...	...	...				5	5	0		
Less—Tax	...	...	...	...	...	...	...				0	6	4		
														4	18	8
General Capital Invested	...	£1,700.														
														£1,961	2	9

ENGINEERS AND SHIPBUILDERS.

FOR SESSION ENDING 31ST JULY, 1902.

Payments.

	£	s.	d.	£	s.	d.
By Transactions and Papers—						
Lithographing	135	9	6			
Printing and Binding	275	6	0			
				410	15	6
„ Stationery and Circulars	104	5	8			
„ Reporting	18	1	0			
„ Rents—						
Offices and Electric Light Fittings	112	12	9			
Lecture Rooms	8	6	0			
Telephone	7	10	0			
				250	15	5
„ Rates, Gas, Electric Light, and Insurance...				32	15	11
„ Salaries—						
Secretary, Salary	400	0	0			
„ Commission	68	11	3			
Assistants'	27	7	0			
„ Postages, Stamps, Post Cards, Parcels, etc.	130	1	0			
„ Secretary's and Office Expenses, Coal, Cleaning, etc. ...	94	4	10			
„ Measured Mile Posts—Rent...	6	6	0			
„ Auditor's Fee	5	5	0			
„ Lantern Expenses	2	15	0			
				734	10	1
„ Library Account—						
New Books	2	15	6			
Bookbinding	11	18	10			
				14	14	4
„ Gold Medals' Fund—						
Gold Medal awarded				5	10	0
„ Graduates' Award Fund—						
Amounts awarded for Papers				7	10	0
„ Tyne Improvement Commissioners—						
Investment at 3½ per cent. per annum				300	0	0
„ Balance at Bank				204	11	6
				£1,961	2	9

THE BALANCE SHEET FOR SESSION ENDING 31ST JULY, 1902.

Liabilities.

		£ s. d.	£ s. d.
Gold Medals' Fund—			
Amount at 31st July, 1901 ...	£298 18 2		
Interest on Investment ...	9 0 6		
		307 18 8	
Less—Medal awarded	5 10 0		
			302 8 8
Graduates' Award Fund—			
Amount at 31st July, 1901 ...	£222 19 6		
Interest on Investment ...	7 2 1		
		230 1 7	
Less—Awards for Papers	7 10 0		
			222 11 7
Payments by Life Members and Associates—			
Amount at 31st July, 1901			231 0 0
Subscriptions paid in advance			4 4 0
General Capital			2,507 7 7
			£3,267 11 10

Audited and certified,
R. W. SISSON, F.C.A.

Newcastle-upon-Tyne,
7th October, 1902.

Assets.

		£ s. d.	£ s. d.
Subscriptions in Arrear—			
Session 1900-1901		7 7 0	
„ 1901-1902		86 12 6	
			93 19 6
Stock of Transactions, valued at			206 2 6
Office and Library Furniture,			
Safe, etc., as at 31st July, 1901		134 10 1	
Less—Depreciation		13 9 0	
			121 1 1
Books in Library—			
As at 31st July, 1901 ...	£337 17 6		
Less—Depreciation ...	33 15 9		
		304 1 9	
Additions this Session—			
Purchases	£2 15 6		
Books received in exchange for Transactions	30 0 0		
		32 15 6	
			336 17 3
Tyne Improvement Commissioners—Investment in respect of the following Accounts, viz.:—			
Gold Medals' Fund		274 0 0	
Graduates' Award Fund and Payments by Life Members and Associates		331 0 0	
General Capital—			
As at 31st July, 1901		1,400 0 0	
Investment 7th November, 1901 ...		300 0 0	
			2,305 0 0
Cash—At Bank			204 11 6
			£3,267 11 10

The PRESIDENT moved the adoption of the Report and Financial Statement.

Mr. E. W. DE RUSETT seconded the motion.

The Reports were thereupon adopted.

VOTE OF THANKS TO MR. GRAVELL.

The PRESIDENT said—I think we should convey to Mr. Gravell, who has given such long service to the Institution in representing it on the College Council, our thanks for those services. I therefore move that the thanks of this Institution be conveyed to Mr. Gravell for his excellent work in connection with the Durham College of Science as representing this Institution.

Prof. R. L. WEIGHTON (Vice-President) said—In seconding this proposal I do so with the very greatest satisfaction indeed; for this reason, that I have been anxious for an opportunity of testifying to the zealousness of the services of Mr. Gravell. I fancy that no one except myself personally is aware how much trouble and time Mr. Gravell has expended over the representation of the Institution on the Council of the Durham College of Science. He has spared neither himself personally, his time, nor his own private means, in furthering the objects of the College. It is now ten or eleven years since Mr. Gravell went there, and I can assure you I have felt his assistance of the very greatest use indeed. I have very great pleasure indeed in seconding the proposal to award to Mr. Gravell our very heartiest vote of thanks.

The motion was carried by acclamation.

PRESIDENTIAL ADDRESS.

By JOHN TWEEDY, Esq., J.P., President.

[Delivered in Newcastle-upon-Tyne, on October 24th, 1902.]

On the opening evening of our nineteenth session I am sure it is your wish that I should identify this Institution with the feelings of thankfulness which pervaded all parts of the country on His Majesty's singularly rapid recovery from a dangerous illness. We are all thankful for his complete restoration to health, and pray that he may enjoy many years of happiness and prosperity. That His Majesty should have spent his period of convalescence with such benefit on board a product of our profession is also a matter of satisfaction to us.

I need scarcely say that I appreciate most fully the honour you have done me in electing me to be your President, but, like others who have preceded me in this chair, I regret the honour carries with it the obligation to deliver an address. The profession to which we are all proud to belong is composed essentially of doers of things—of workers accustomed to express themselves by the designing pencil and the noisy hammer. The Institution has, however, filled our bookshelves with most instructive and useful original papers, and the pen has become an aid to the pencil. Its roll of members lengthens yearly, while its finances continue in a healthy condition. Another gratifying feature is that the Institution has become a centre to which all kinds of questions involving the professional welfare of its members converge for consideration.

Technical education is one of these questions. To the influence of our Institution it is mainly due that the Durham College of Science in Newcastle has already become a centre of higher technical education in subjects of paramount importance to engineers and shipbuilders. The Institution is represented at Lloyds and at the Board of Trade, and assists both these bodies

in their important work, and it would doubtless have been asked to settle the question of the New Quay if the Mayor and Corporation of Newcastle had been aware of its existence.

The 18 years during which our Institution has existed has been marked by the construction, in this district, of some of the finest ships for war and commercial purposes and by the introduction of many novel types both of ships and machinery. Excellent work has been done by individual members in many fields, and I am sure I shall only be giving expression to your feelings as to my own, when I congratulate the Institution in being able to claim as a member the remarkable man who, by his splendid abilities and courage, has firmly established the steam turbine as a rival to the reciprocating engine. The Hon. Charles Parsons is a doer of things. He has achieved a great work, and his name, like that of Stephenson and Armstrong, adds lustre to the North where so much of his best work has been done.

It is interesting to learn from a recent paper by Mr. Parsons that the total of all compound parallel flow turbines at work and on order for generating electricity reaches the large aggregate of about 300,000 horsepower. The steam turbine has already been applied with complete success to a number of steamships, of which, up to the present, the most notable are perhaps the "King Edward" and the "Queen Alexandra." The total aggregate indicated horsepower fitted, or being fitted, in steamships is already about 83,000. So far turbines have only been fitted in relatively small vessels of very high speed, and, although their suitability for vessels of large dimensions and relatively low speed has not yet been proved by actual test, the indications are clearly that they will be equally, if not even more, successful in such ships, and that we shall see in the not far distant future our largest vessels fitted with turbines.

I propose to confine myself to a few remarks on two or three general subjects of special interest to us all at the present time. Time prevents me making even a passing reference to numerous other important subjects which have received the recent attention of members, but I should like to take this opportunity of pointing out, especially to our younger members, that one of the great charms of our profession is that it seldom permits of a last word being said by anyone, however great, on

even the simplest technical question. There is probably no subject, however ably it may have been treated in the *Transactions* of preceding years, which to-day is not capable of further treatment or of being viewed from another standpoint, and data, as we all know to our cost, require constant correction and extension, so that I hope a number of members and associates are already engaged in the preparation of such papers on old, as well as papers on new, subjects.

The question of weights and measures has long occupied the attention of this and kindred Institutions, and it is to be regretted that Mr. Baines, one of our Vice-Presidents, who has made the subject so much his own, has been unable to give the time to it recently which his abilities and knowledge would have made so profitable to the cause. It has been very well said that there is no need to invoke the assistance of Parliament, but that, if they wished to do so, they might themselves introduce a different system of measurement into their own works. This is quite true. Already a number of firms have done so with success, but we have all had experience in dealing with the inertia of matter, we know how persevering it is in following any path, whether that path be a right or a wrong one. The inertia of the human mind is probably quite as persistent, and it is doubtful whether this inertia will be overcome, and a better system of weights and measures become general in a reasonable time, by the humble force of isolated individual effort.

To succeed in the struggle for existence as a great industrial nation, into which, I am pessimistical enough to think we are entering, we shall have to abandon, not only obsolete machine tools, but obsolete methods and ancient prejudices as well, and amongst them this one of weights and measures would appear to call for early attention. Science does not now express itself in feet and inches, in pounds and ounces, and apart from the important commercial reasons for a change, our prejudices must no longer compel our youth to study science in a language which must be abandoned the moment he commences to apply his knowledge to practical purposes. I venture to hope, therefore, that interest in the subject will be revived in this district and that the Institution as a body, and its members individually, will find an opportunity of helping in the work of establishing a less cumbersome system of weights and measures.

For a long time our Institution has taken an active part in the efforts which are being made to secure reforms in the organization and training of the engineering *personnel* of His Majesty's Navy. Mr. D. B. Morison, one of our Vice-Presidents, has ungrudgingly given his best time and great abilities to the subject, and it is almost entirely due to his energetic action that it is now more generally understood throughout the country how very important, how very serious and urgent, the question is. Interest in it continues to increase. The Press, especially the technical press, is full of the subject.

It is useful to remember that the machinery of the Navy did not originate within the service. It originated and has been developed and perfected, and is to a large extent manipulated, by members of the engineering profession represented by this and kindred Institutions. It is still designed and constructed by such members. They are still, both professionally and financially, responsible up to a certain point for its efficiency. It is also to be remembered that the problems involved, not only in the design and construction, but also in the operation of the complicated machinery, become daily more abstruse and recede more and more from the comprehension of the non-technical mind, so that, in addition to the national aspect of the question Institutions of this kind have the further interests of their profession to compel them to give the closest attention to the question of reform of the engineering branch of H.M. Navy.

The experience of centuries insists upon the presence, in each branch of all military organizations, of officers specially trained in the duties of the men they command, and also upon a clear and firm line being drawn between the officers and men for purposes of discipline, but experience also teaches that, to be really effective and to bring out and develop the best qualities of officers and men alike, the differentiation must be sympathetic. In olden days the soldier ruled the sea, but he ceased to do so when, long ago, it was found that discipline is most perfect and the sailor at his best when he is ruled by capable self-reliant sailor officers, trained and interested in every duty in the daily routine of a sailor's life, understanding his prejudices and his habits.

The Army, including its engineering branch, and the Navy, but excluding its engineering branch, have both been organized on this foundation of sympathy in taste and experiences. Un-

fortunately the naval engineering *personnel* is not so organized. It is relatively a new branch and the Admiralty Board does not appear to make sufficient allowance for its idiosyncrasies, history and experiences, all peculiar to itself, and which, as in the case of the sailors, can only be properly disciplined and utilized for the common good, by officers of clearly defined rank and position possessing the requisite technical knowledge to be able to lead their men in the everyday duties of the branch. Our corps of Royal Engineers are commanded by engineer officers, our cavalry by cavalry officers, our sailors by sailors, and if we are to secure in the engineering branch of the Navy all the benefits of this secondary discipline, this discipline of respect arising from a common occupation, which in critical moments supersedes all formal codes, the engineering *personnel* must also be commanded by engineers.

At present the engineer officer is not an officer of the military branch of the Navy, he holds no rank. He is a layman, a capable technical expert in much the same position on board a warship as a guarantee engineer on board a foreign merchant steamer, active in the purely technical duties of an officer, but still not an officer endowed with the necessary military powers in his own department, which experience points out as being absolutely necessary for efficiency. Lord Goschen has described a modern warship as a fiendish complication of machinery. Professor Weighton says of it, that it is perhaps the most awe-inspiring aggregation of power in one unit yet devised by man. No one having the least knowledge of the subject will consider either of these descriptions exaggerated, but only engineers of experience can fully appreciate the great responsibility, even in times of peace, resting upon the men in charge of such machinery. Captain Mahan, probably the best known and ablest writer on naval matters, has said that "historically good men with poor ships are superior to poor men with good ships." In other words, the degree to which the latent fighting value of naval *materiel* can be rendered effective, is determined by the sufficiency, skill and discipline of the *personnel*. Improperly handled, the most perfect machinery, like the finest ship, may become a source of weakness instead of strength to a nation.

We believe Captain Mahan's historical deduction to be sound. We know, as engineers and shipbuilders, that Lord Goschen's and

Professor Weighton's descriptions are accurate, and I think we must conclude, as engineers accustomed to the design, construction and operation of complicated machinery, that if the best is to be made of the *materiel* of the Royal Navy, if the nation is to avoid the dissipation of its resources without adequate return in effective work, it is imperative that, in this branch as in all other branches of the service, the *personnel* shall always be in advance of the known immediate requirements of the *materiel*, that as the *materiel* increases in amount, dimensions and complexity, so must the standard of entry be raised and that whether, in future, the officer in charge of the machinery be a sailor, or a gunner as well, he must at least be specially educated and trained as an engineer, skilled not only in the operation but also understanding the design and construction, and therefore the possibilities and limitations of the machinery in his charge.

But Mr. Morison has shown (and his contention has received the support of all engineers who have seriously considered the subject, of many members of Parliament, and of naval officers of position and experience), that these primary conditions of efficiency are not, and cannot be complied with by this branch of the service as at present organized. He has also shown that the *materiel* has reached, if it is not already dangerously beyond, the point fixed by experience as the limit of the effective controlling capacity of the *personnel*, and that while the machinery is increasing in extent and complexity, calling for still higher qualifications and more rigid selection, the standard of entry of engineer officers into the service has been lowered, but so unattractive has the branch become that even this lowered standard has failed to secure a sufficient number of entries.

This cannot be considered a satisfactory state of affairs, and a significant commentary is supplied by the action of many of the headmasters of our great public schools in having ceased to recommend parents to enter their sons for the engineering branch of the Royal Navy. They have urged upon the Admiralty in a resolution of the Incorporated Association of Headmasters, "that until the service is made more attractive as to both the status and the pay of these officers, there will be a dearth of many desirable candidates, and a great loss of efficiency to the nation."

Various proposals have been made by naval officers, engineers, members of Parliament and others for the improvement of this

important branch, which already numbers about one-third of the total *personnel* of the Royal Navy. Twenty-eight years ago a committee appointed by the Admiralty, under the presidency of Admiral Sir A. Cooper Key, recommended among other things that engineer officers in future be classed with the military or executive branch of the Service, amongst those who could not on any occasion succeed to command.

No one doubts but that the present Admiralty Board is actuated by the keenest desire to place the department on a sure foundation of efficiency, but the Royal Navy is so vast a machine, its organization so intricate, so rusty with age and the legacy of difficulty inherited by its present members so great, as to make unaided movement exceedingly difficult and perhaps hazardous. It is to be hoped, therefore, that the Admiralty Board will strengthen itself in regard to this question by appointing a strong Commission, composed of experts from the inside and a few competent persons from the outside, to consider and report to them upon the whole question.

I have already referred to the interest this Institution has always taken in the question of education in technical science. I think there can be no doubt but that the best educated nation will take the lead, and it is satisfactory to observe that all classes of the community are now taking more interest than ever before, in educational questions. Although in a chaotic condition at the moment, it may still, I think, be said that some progress is being made with elementary education. Secondary education is receiving more, but still far from sufficient, attention, while the establishment of science colleges and the extension of universities and improvements in their methods are bringing higher general and technical education into closer touch with our national life.

Of course neither general nor technical education are ends in themselves, but only means to an end—tools as it were; the one helpful in the formation of orderly habits, in the development of character and in conferring upon its possessor the benefits of a limitless source of healthy recreation; and the other in the utilization of these habits, of this character, and of the energies refreshed by these recreations, in the field, the workshop and office. It has been well said, that while the point at which general culture ceases to be beneficial, can never be reached by an artisan, or any man, no matter what his vocation may be, the

point at which technical culture really makes an artisan more efficient as an artisan is soon reached, and reached, in most cases, more quickly in a workshop than in any school or college. We do not all require to be educated in technical subjects, such as engineering and shipbuilding, but we do all require to possess the power to use books and to enjoy reading. A trade or a profession cannot be taught in a school, and even admitting most fully the urgent necessity for a generous and diffused scientific technical education, I venture to say that no greater mistake can be made by educationists than to substitute technical instruction, more especially that branch of it which deals only with the craft of the hand, for general education during the more tender and impressionable years of a boy's life.

How to live sensibly and rationally is a more abstract, a more difficult problem than how to turn a shaft or plate a ship, and a less skilful workman, but a good man, may be superior, even from the economic point of view of the workshop, to a workman, more skilful as a workman, but inferior as a man. The skill of the workman of this country has not deteriorated. Whatever his faults may be in other respects he is still, as a mechanic, the best in the world. If we are falling behind other nations it is not because we are less skilful as artisans. It is because as a nation our education is less general and thorough, and selection for any given duties operates in too narrow a field.

Technical culture must follow and not precede general culture. It can only be acquired with reasonable economy of time and expense, by a mind already expanded and prepared by general education of the right kind. That the present preparatory teaching is scarcely what is required for the purpose has been made clear by experts, and in the meantime scientific technical education must progress less rapidly than it otherwise would.

No argument is needed to shew that scientific technical education is absolutely necessary. Formerly a small number of men of commanding natural abilities might suffice for the control and development of our industrial undertakings. In this country there has never been a lack of such men. They made it long ago the home of discovery and invention, and the industrial centre of the modern world. This is not the case to-day. Technical problems have become so difficult and complex that

empirical methods no longer suffice, and even the greatest abilities, equally with the more humble, must now be prepared by scientific technical training before such problems can even be understood, much less solved.

Steam economy (to refer only to prime movers) has already reached a stage which can hardly be much exceeded, still the demand for further economy remains, and other conditions are being set which require the highest precision in the designing and administrative departments of our works in order to attain their fulfilment. The gas engine, by its high thermal efficiency and the progress in the art of making producer gas, comes more and more into the department of ordinary power engines in competition with the steam engine, while the utilization of blast furnace gas in gas engines will revolutionize the power plants of smelting works, and probably also of electric generating stations. The intrusion of electricity into the various branches of industry makes still higher demands on technical scientific acquirements. Electricity has introduced new conditions. It has compelled engineers to introduce an exactness in design and construction of engines and machinery of all kinds hitherto unknown.

Unfortunately, but very naturally, our pride in the practical qualities which, it is admitted, the people of these islands possess in a high degree, has caused us to look askance on what is called theory. But it is now better understood that these qualities, which have overcome so many obstacles in the past, are not antagonistic to science and scientific acquirements, but that, on the contrary, one is a supplement to the other, theory liberating our practical common sense from the prejudices of empiricism and enabling it to penetrate deeper into the secrets of nature, and to extract from these greater depths still more important results.

The instrument which, it is hoped, will render the gifts of the nation more effective is not, on the one hand, the teaching of handicrafts in a school or, on the other, instruction in a college in one-sided theoretical speculations, but in the natural blending of science with our practical gifts in such a way as to leave these gifts as free and unimpaired in action in regard to the larger and more complicated problems of the future, as they have hitherto been in regard to the less complex ones of the past.

Germany has also her technical education question, and it is

useful to note in regard to it, that while our position is largely due to our unaided practical abilities, that of Germany may be said to be due almost wholly to her superior theoretical knowledge. Our methods have leaned too long to the empirical side, while in Germany the theoretical side has hitherto predominated, with the result that, for example, a Prussian State engineer at 30 years of age, may have only just passed his final examination. But already Germany is moving rapidly in the direction of a more practical and less theoretical training, the movement being largely due to the teaching and influence of such men as Professor Riedler of Berlin.

In consequence of this teaching it is now understood in Germany, as it has always been understood here, firstly, that the practical solution of most technical problems must in the future, as in the past, be the work, not of pure mathematicians or other theorists, but of scientifically trained practical men; and secondly, that the technical instruction of such men, to be really effective, must moreover be conducted by scientific practical men who have in addition specialized for teaching. The movement in Germany is, consequently, not now toward an augmentation in the number of mathematicians and natural philosophers in technical colleges (for whose subjects sufficient provision already exists) but towards an augmentation of directly technical instruction, scientific research and experimental observation.

England has led in this, and introduced such training earlier than Germany. England also realised sooner, and sooner took advantage of the knowledge that technical education must be conducted by men of experience in the application to practical purposes of the science they teach.

From what we see abroad we may conclude, I think, that the foundations of our structure have been laid on fairly firm ground. But we are at a great disadvantage, as compared with Germany, in that our superstructure contains too little real science. Whatever laboratory training is given is too often diluted with the teaching of mere handicrafts. "School-shops" being separated from commercial production can never be efficient, and what is even more serious the parents of the pupils of these "school-shops" believe their sons have gathered some useful technical knowledge, while in reality they have only learned some handi-

craft, which moreover, is seldom such as is required in the real practice of industrial life.

The scientific technical training which is being developed in Germany and America, and the extension of which is required in this country, and which I am glad to say is pursued at the Durham College of Science, is entirely different from that obtainable in the school or college *workshop*, and has quite a different purpose. Its purpose is to teach the student to think and observe correctly, to impart to him scientific knowledge, not alone by theoretical instruction, but also, and perhaps mainly, by teaching him to put his theoretical knowledge to the immediate test of experiment, and by practical instruction in the art of close accurate observation and careful measurement to accustom him to look for and recognize the influence of agencies, not perhaps mentioned in his text books but which are almost certain to be present, and which, if not observed, will lead him to quite wrong conclusions. This is the higher and more scientific training Germany is providing for her students. At the same time her feeling for pure science, her devotion to abstract scientific research and close study, for which she has long been celebrated, will remain unimpaired. But the results of these more theoretical studies will be combined by the scientific practical man with the lessons of practical observation, and Germany will become an even more formidable rival in invention and discovery.

Probably the best method of acquiring this technical training would be one which combines the college and the commercial workshop, in such a way as to prevent the student losing touch of either, while he is a student. Several ways might be adopted, probably the best being that in which the summer months are spent in the workshops or drawing office of a commercial establishment, and the winter months at college lectures and experimental laboratory work. To work such a system it is obvious that the co-operation of the employers will be necessary. This system is, I understand, in partial operation at the Durham College of Science, and when adopted it works well, affording as it does the most economical use possible of the students' time. One considerable drawback, however, lies in the fact that in many works a premium is demanded by the employer, as a set-off for the privilege of being allowed to attend college during the

winter. This demand shuts out many of the most promising lads from the benefits obtainable, and the profession and nation are thereby the losers.

The premium system was introduced for the purpose of providing the special training considered necessary for youths destined for the higher positions in industrial undertakings. It cannot be said to have ever been a very satisfactory system, but its adoption was perhaps excusable at a time when, having passed through all the departments of a works including the drawing office, a young man might claim to have completely qualified himself for his future duties. The expert of the future cannot be wholly trained in this way (excepting, of course, the exceptional youth who may be said to be independent of school, college and workshop alike), he must also receive instruction in technical science away from the works. The combination of the college and the workshop ought surely to make the apprentice more, and not less, useful to his employer, and I would recommend my brother employers to seriously consider whether the time has not now arrived when the entry of special pupils into works should be by proficiency and merit as a student, and the premium system be entirely abolished.

The sharpening of our gift of common sense by the higher technical education I have been alluding to is equally required in shipbuilding, engineering, and in most, if not all, the industrial arts. I am not competent to speak in regard to the great chemical and more purely metallurgical industries, but even in these I am informed that there is room for improvement.

Recently in Berlin I found a metallurgist at work in a relatively small iron foundry, and was informed by the proprietor that he was one of the most important men in the foundry. Many youths eminently qualified for such work, both by their superior scientific training and natural bent, must, under the present system, pass through our colleges and be lost to the industry they are best fitted to develop and improve through lack of opportunity to check and combine their theoretical studies with the lessons of practical experience. I am sure that an important step forward would be made if our more enterprising founders were to give facilities to *selected* students for concurrent practical observation in their workshops.

If we are to maintain our position in the affairs of the world

we shall have to discard all prejudices and antiquated methods, and apply ourselves with diligence to the improvement of our educational machinery. We shall have to prepare a foundation of sound sensible general culture on which to build a superstructure of technical scientific education higher and broader than exists at present in this country.

Unfortunately Parliament, County Councils and other public bodies do not seem to consider they have much duty in the matter of technical education in the various branches of engineering and shipbuilding. It is, therefore, all the more necessary that all interested in these industries should bestir themselves and actively support, both financially and otherwise, a sound system of technical education. This, as much in their own individual interests as in the ultimate interests of their country.

In the year of the *débâcle* in shipping, as some think it is—of the hopeful awakening to our real position, as others more profitably name it—some reference to the American Combine may be expected in an address of this kind to engineers and shipbuilders.

Since the exhaustion of the Spaniards and Portuguese by their great discoveries and conquests, no nation has displayed more aptitude for the sea, none have produced more courageous and resolute navigators or more adventurous owners, and probably no nation, not excepting even the Venetians, has ever depended more upon its fleet of merchantmen or has been more jealous of its position on the sea than the British.

It is not surprising, therefore, that the people of this country, and of Greater Britain as well, were alarmed by the wholesale transference, to an American Company, of ships whose names had become household words to us. But we sell ships abroad every day, and the transfer to another nation of a few more thousands of tons of shipping was of course not in itself the cause of the alarm, as much as the indication the transaction was supposed to furnish of the decadence of the commercial instincts and enterprise of this country.

Of course the real merits of the case can only, as yet, be fully known to the two parties to the transaction, and as one of the parties is composed of shrewd capable men of our own nation, imbued with the same patriotism and feelings as ourselves, it is conceivable that their better information enables them to pierce

further into the future, and to see sunshine behind the clouds which alone are visible to you and me.

We can only hope that this is so, and that, although natural and excusable, the alarm of the nation may prove to have been quite unjustified.

Anxiety in regard to the transaction has been intensified by a doubt arising largely from our history. The talents of a man, like his wealth, may be his own property to dispose of as he may think best. The nation witnesses with satisfaction the successful operation of these talents in the great shipping houses, but it looks upon these houses as the successors of the great navigators and adventurous owners of the past, and holds them responsible for the maintenance of our opportunities for development on the seas. It discriminates between the sale to other nations of a spinning machine, a ship, or a gun, and the sale of prominent lines of steamships along with all the prestige and opportunities which the possession of such lines confers upon a nation.

That we have been alarmed is, however, a hopeful sign and good must come of it. Already our Town Authorities, our Harbour and Dock Commissions, our Parliament and Cabinet Ministers are displaying an interest in shipping matters, not greater than before perhaps, but of a different kind. They are becoming less interested in shipping as furnishing opportunities for the exercise of their controlling and regulating powers, and instead, are beginning to sympathize more with projects for its liberation and development.

Of course we can build steamers equal in size and speed to the vessels built by our pupils abroad, but we require an owner to give the order, who in his turn requires dock and harbour facilities to enable him to work his larger and faster steamers with the same economy and efficiency as his competitor in Germany, and I venture to express the doubt whether, at the present moment, facilities exist in this country for the rapid and economical handling of the largest and fastest Atlantic liners equal to those possessed by at least one of our competitors.

That there is a prospect of England again possessing vessels of the highest speed at an early date is most gratifying, although of course, it is to be regretted that any provision of the nature of a subsidy should be necessary.

As taxpayers we would have been delighted if the Cunard

Company had seen their way to place three or four 25-knot steamers at the disposal of the nation without payment of any kind. This they are not able to do, vessels of such high speed cannot, at present, be run by this country so as to be commercially remunerative, and if the nation wishes to command the services of such vessels for cruising purposes, it is clear it must pay for the privilege and abandon the use of the word subsidy in connection with the agreement between the Government and the Cunard Company. That it is necessary that such vessels should be at the disposal of the Admiralty is, I think, generally admitted, and I think we must, therefore, consider the combination a happy one, which, while satisfying this demand, at the same time safeguards, to some extent, our position as a great shipping nation. But after all it is not by Government assistance our supremacy as a shipping nation can be maintained, but by the improvements of our methods and by our energy and perseverance as a people.

This is not the first time in our history that our position on the sea has caused anxiety. Prior to the American Civil War American shipping and shipbuilding became very powerful in the Atlantic, but the enterprise of the British in introducing iron into shipbuilding and in developing steam propulsion succeeded in securing the position threatened by our American friends. Neither was our position satisfactory in the days of Sir Walter Raleigh, and we may, I think, derive hope and encouragement, in that, having succeeded in retrieving our position in the 17th and 19th centuries, we shall likewise succeed in the 20th century. In the early years of the reign of James I. Sir Walter complained "that the Dutch were everywhere outstripping the English, and especially monopolizing the carrying trade by the structure or roominess of their shipping holding much merchandise, though sailing with fewer hands than our ships could, thereby carrying their goods much cheaper to and from foreign parts than England can; whereby the Dutch gain all the foreign freight, whilst our ships lie idle and decay, or else go to Newcastle for coals."*

* *Observations concerning the Trade and Commerce of England with the Dutch and other Foreign Nations*, 1603.

Mr. HENRY WITHY (Past-President) said—The President has regretted that one of his first duties was to prepare and deliver an address. We to-night have heard that address, and I am quite sure we do not share his regret. We have listened with very great pleasure to Mr. Tweedy's views upon the subject of technical education. I consider they are very valuable. His address is a most thoughtfully worked out one, and he has shown us, I think, exactly the proper mean between what we may call the higher theoretical training prevalent in Germany and the more practical training here. I am sorry there are none of the other Past-Presidents here. As junior Past-President the duty devolves upon me, but it is an exceedingly pleasant duty to ask you to pass a hearty vote of thanks to Mr. Tweedy, our new President, for his exceedingly able address.

Prof. R. L. WEIGHTON said—I rise with the very greatest pleasure indeed to second this proposal. I think this address of our new President shows that he must have burned a good deal of the midnight oil. It is most thoughtful. Indeed, so much so, that I think a first reading will not convey the full meaning of a good deal of it. It will stand being read over again and studied, and that is a feature which we do not find in most addresses. I therefore beg to second, most heartily, this proposal.

Mr. E. W. DE RUSETT said—I have very much pleasure in supporting the movers of the resolution.

The motion was carried by cordial acclamation.

The PRESIDENT said—I am really very much obliged to you all for the very hearty way in which you have responded to the proposal of the vote of thanks. My predecessor, Mr. Withy, was good enough to explain to me how very generous the members of this Institution are. I have found his words quite true. I should like to make one remark, intended mainly for those who can find time to interest themselves in educational matters. It is not reassuring to find that in most chemical industries we are largely outstripped by our neighbours across the water. Even our armour plates are made under foreign patents. The fastest ship crossing the Atlantic is not an English ship. It is a

German flag that flies at the masthead. You will find our electrical stations, go where you will in England, perhaps filled with English engines but not with English electrical machinery. To-day, for our smelting works, numbers of orders have been given for gas engines to be driven by blast-furnace gas. The gas engines which will utilise the blast-furnace gas, which at present blackens the sky, is not a gas engine designed by England. I am glad to hear that, Messrs. Richardson & Westgarth having purchased various rights, the engine may be made in England, but the conception and development of it is not due to these islands but comes from across the sea. I think these are lessons that we all ought to take to heart and assist as much as we possibly can in encouraging educational work. I thank you very much for the way in which you have received my remarks.

The meeting then dissolved.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.

NINETEENTH SESSION, 1902-1903.

PROCEEDINGS.

THE SECOND GENERAL MEETING OF THE SESSION WAS HELD IN THE LECTURE THEATRE OF THE LITERARY AND PHILOSOPHICAL SOCIETY, WESTGATE ROAD, NEWCASTLE-UPON-TYNE, ON FRIDAY, THE 21ST NOVEMBER, 1902.

JOHN TWEEDY, ESQ., J.P., PRESIDENT, IN THE CHAIR.

The SECRETARY read the minutes of the previous meeting, held in Newcastle-upon-Tyne on Friday evening, October 24th, 1902, which were confirmed by the members present and signed by the President.

The President appointed Mr. Henry Withy, J.P., and Mr. D. Andrew to examine the voting papers for new members, and the following gentlemen were declared elected:—

MEMBERS.

Amos, Ewart Charles, Consulting Engineer, 20, Bucklersbury, Queen Victoria Street, London, E.C.

Bryers, Charles, Superintendent Engineer, 10, The Avenue, Sunderland.

Cullen, Harold Rigby, Engineer, Durham College of Science, Barrass Bridge, Newcastle-upon-Tyne.

Fairbairn, William Armstrong, Naval Architect and Engineer, P.O. Box 273, New London, Conn., U.S.A.

Garson, Stanley T., Iron Manufacturer, 5, Rome Terrace, Borough Road, Middlesborough.

Le Rossignol, Alfred Ernest, Electrical Engineer, 8, Victoria Square, Newcastle-upon-Tyne.

Male, Francis John, Mining Engineer, 4, Normanby Terrace, Gateshead-on-Tyne.

Morton, John, Engineer, 18, St. George's Square, Sunderland.

GRADUATES TO MEMBERS.

Potts, Herbert Joseph, Engineer Draughtsman, 42, Grosvenor Place, Jesmond, Newcastle-upon-Tyne.

Thew, Charlton, Engineer, 80, Osborne Road, Newcastle-upon-Tyne.

ASSOCIATE.

Levin, Otto, Accountant, Maritime Buildings, King Street, Newcastle-upon-Tyne.

GRADUATE.

Finlay, George, Engineer, 27, Clayton Park Square, Newcastle-upon-Tyne.

Mr. JOHN H. HECK read a paper on "Fire Extinguishing Apparatus for Ships."

FIRE EXTINGUISHING APPARATUS FOR SHIPS.

By JOHN H. HECK, Member of Council.

[Read in Newcastle-upon-Tyne, on November 21st, 1902.]

Much has been done during the last few years to render vessels safer at sea, and there is no doubt that loss of life and property is very much less now than it has ever been before. This is largely due to the skill and work of the engineer and shipbuilder and to the help which they have had from the shipowners and those in touch with them. There is one peril, however, and a great one it is, that very little has been done in the matter of coping with fire at sea. When a fire breaks out it may mean the loss of the ship and crew, and even if this is not so it means, very often, the loss of costly cargo through damage by fire, water or steam. One has only to look back during the last few years at the list of vessels which have been burnt and the number which have been on fire to see at once that it is a subject worthy of notice by all having any stake in shipping, cargo or safety, and it is this opinion which has led me to put this paper forward.

In many sailing ships at the present day the only means of putting out fire is by the ordinary bucket and water drawn from the ship's side, such as is done when washing decks. In some cases a hand fire-pump is supplied, very often of small size and totally unable to cope with a fire of any dimensions. In pouring water into the hold of a sailing vessel in which fire has taken place from any cause, the water may not reach anywhere near the source of the fire and therefore do very little good.

Most cargo sailing vessels at the present day have a donkey boiler, and some are fitted with a good donkey pump able to pump a stream of water through a hose either on deck or into the holds; but even in such cases much water may be pumped in without reaching the seat of the fire, which may grow larger and larger in extent.

If the cargo in a vessel takes fire water very often is of very little use to put it out unless it can be played right on or near the spot where the fire is burning, and even if it is put out there is generally damage done to the cargo. To put fire out in a loaded vessel with water means loss of money. Forty years ago this was known, and for this reason in some cases steam pipes were fitted in order to put out fire, and this system has also been followed in various steamers to the present day.

The point urged in favour of steam over water was this: that while water may not find its way to the fire, steam, owing to its expansion, will do so. The steam, of course, to be of service must be ready day and night. Steam, however, will damage a valuable cargo just as much as water, besides it is very wasteful.

It was stated some time ago that on a vessel which was coming across the Atlantic loaded with cotton, and fitted with steam pipes, the cotton took fire and the steam was turned on the holds with the result that the engines nearly stopped, through the great consumption of steam.

In my opinion, to attempt to put out fires on ships with steam alone is not a scientific, economical or practical way, and this appears to have been the opinion of Captain Shaw, the late Chief of the Metropolitan Fire Brigade, who, at a meeting of the Society of Arts, in London, stated:—"With regard to steam for extinguishing fire, experiments had been made over and over again, and he hoped some day to see with some slight modification a system of extinguishing fire by steam, where it could be well applied, as for instance on board ship; but it was only right to warn those interested in the matter that hitherto such experiments had never yet been successful. He had tried them as far as anybody had power to do and with more completeness than could be expected almost anywhere, and hitherto had not succeeded; still he did not give it up, and he hoped the time would come when, by the mixture of something with steam, the desired service would be obtained. At present, however, it would be a mistake to say that you could extinguish fire by steam alone." Combustion, of course, cannot take place where steam is present, but the steam rapidly condenses, and taking it altogether it is a question whether water is not superior to steam in putting out fire; water is cheap and abundant, and when thrown on a fire it evaporates and forms steam, the production of which tends to

exclude the oxygen, and as is known, the steam produced will not support combustion.

Extincteurs or chemical fire hand engines have been tried; they usually consist of a cylinder containing a solution of carbonate of soda. On the application of an acid, carbon dioxide is rapidly formed, the pressure rises and the contents can be directed by a nozzle on to the fire.

There are many varieties, and they are no doubt useful for first aid in putting out fires; they, however, require care and attention and appear not to have met with much favour on ships.

Carbon dioxide, as is well known, will not support combustion; it is, however, difficult and expensive to make on board ship.

Some thirty years ago several vessels were fitted with an apparatus for producing quantities of carbon dioxide for the purpose of extinguishing fires.

In some vessels tanks containing a carbonate and a bottle of acid were placed in the hold; an iron rod came through the deck. On an alarm of fire the bottle of acid was broken by the rod and carbon dioxide of course instantly formed thus tending to put out any fire.

Some vessels were also fitted by Mr. James Paton with his fire extinguishing apparatus, which he called a pyrometer. In this apparatus a carbonate was also used in conjunction with hydrochloric acid. It consisted of a metal vessel and two pumps, one pumping the acid, and the other the carbonate solution into a generator, where carbon dioxide was formed. A full and interesting description of these arrangements is given in the *Proceedings* of the I.N.A. so far back as the year 1873. At the present time, so far as can be ascertained, there is only one vessel fitted with a carbon dioxide extinguishing apparatus. It consists, it is stated, of about sixty tubes, each containing about 40 lbs. of liquid CO_2. This vessel made a voyage to the East this year.

Sulphur dioxide, SO_2, and in fact most gases, oxygen, of course, excepted, will not support combustion. Sulphur dioxide, however, can be cheaply and easily and quickly made on board ship. An atmosphere containing 10 per cent. of this gas will at once extinguish and also prevent the formation of fire or flame, and petroleum vapour if mixed with this gas will not explode.

A series of very interesting experiments was made last year with this gas by the North-Eastern Marine Engineering Company at their works at Wallsend, the gas being produced by the Clayton fire extinguishing apparatus. A brick chamber was built, and a quantity of wood saturated with naphtha inserted. The wood on being ignited was soon in a blaze; the machine was then started and the sulphur dioxide formed and pumped into the chamber; its effect was very rapid in extinguishing the fire. Burning torches when thrust into the chamber containing the gas were also at once put out.

A number of steamers and sailing vessels have now been and others are in course of being fitted with the Clayton extinguishing apparatus, which can be used with great advantage on board ship, especially in closed spaces or compartments, such as the holds and bunkers. It is stated that many insurance companies and underwriters have given preferential insurance rates to vessels fitted with this apparatus, this reduction of premium for insurance being due not only to the rapidity with which fire is extinguished, but also because it may be used to prevent fires, and if it has to be used and the air is not too moist it will not damage most cargoes.

It may be mentioned that very often in vessels the damage done to the cargo by water used in putting out a fire is much greater than that caused by the fire itself.

The apparatus has also been very largely employed for fumigating and disinfecting purposes and also for ridding vessels of all kinds of vermin. On filling the hold with a percentage of the gas rats and other vermin leave their hiding places and come out into the hold to seek fresh air and there perish.

Briefly described the Clayton fire extinguisher consists of a generator for burning sulphur, a cooler or condenser, a fan and an engine for driving the same.

The action of the apparatus is as follows:—Ordinary roll sulphur is placed on a tray in the generator and ignited by means of waste or other material saturated with naphtha or petroleum; the fan is then started and draws the air from outside or from any desired compartment through a special valve into the generator, through the burning sulphur; the oxygen of the air unites with the sulphur, forming sulphur dioxide, SO_2; this is drawn through the tubes of the cooler, which tubes are kept cool by a small

circulation of water around them; the gas then enters the fan and is forced by it into any desired compartment. There are two sets of pipes leading from the machine to the various compartments, one being a discharge line and the other a suction line; suitable valves are placed so that the discharge from the fan or the suction to the cooler or generator can be taken to or from any desired compartment.

When the fire has been extinguished in any compartment the flow of fresh sulphur dioxide is stopped, and by means of a circuit change valve the communication to the generator is closed. The hot, gas-laden atmosphere in the compartment is then simply drawn through the cooler, sent back again by means of the fan into the compartment and so on; the hot, gas-laden atmosphere continually being drawn through the cooler and returned to the compartment until the atmosphere is reduced in temperature to about 100° Fahr. when there is no more probability of the fire rekindling. This cooling of the atmosphere in the compartment where fire has taken place is one of the chief and important points of this system. To open up the compartment before the temperature of the air has been reduced would simply cause the fire to burst out again, and that has been proved by numerous experiments.

The apparatus is very simple and can be understood by almost anyone on board; there is practically nothing to get out of order, it takes up very little room, is always ready for use, and can be worked very cheaply. The steam for the small engine which works the fan is taken from either the main or donkey boiler, and the circulating water in the cooler or condenser can be obtained from any of the donkey pumps on board. The apparatus is also so arranged that by means of a bye-pass valve the gas can be drawn direct from the generator to the fan without passing through the cooler.

In special cases this apparatus is made self-contained, that is, a small oil engine drives both the fan and a small pump for circulating the water in the cooler, the suction pipe being simply a hose led over the ship's side.

In my opinion some fire extinguisher of this kind would be of great value, not only if fitted to petroleum steamers, but vessels carrying coal, cotton or other cargoes liable to spontaneous combustion, especially on long voyages, and to steamers generally.

The paper was illustrated by lantern slides.

Slides and Figures Nos. 1, 2, 3 and 4 (Plate II.) show the outward appearance from different points of view of the apparatus.

Figure No. 5 (Plate III.) shows the elevation of the machine in section.

Figure No. 6 (Plate III.) and slide show the end view of the machine with sections through the generator, gas chamber, circuit change and cooler head.

Figure and slide No. 7 (Plate III.) show the front and end view of the generator, blower in section, and gas track from blower to cooler.

Figure and slide No. 8 (Plate III.) show machine in plan, generator in section, showing air-feed and gas track through generator, also sections through cooler, gas chamber and circuit change.

Figure and slide No. 10 (Plate V.) show an illustration of the sulphur dioxide machine applied to a sailing vessel.

Figure and slide No. 9 (Plate IV.) show the application of the same process to a steamer.

Figure No. 11 (Plate VI.) shows part of the application on a steamer of steam fire extinguishing apparatus.

APPENDIX.

EXTRACTS OF REPORT BY PROFESSOR WYNDHAM R. DUNSTAN, F.R.S.

As regards oils, sulphur dioxide is slightly absorbed by petroleum, more so if the gas is forced through the liquid than if merely in contact with the surface. The liquid is, however, little if at all changed by the solution of the gas in it.

Vegetable oils (*e.g.*, olive oil and linseed oil) absorb sulphur dioxide, becoming brown and gradually forming black deposits. It is, therefore, not safe to expose vegetable oils to air containing sulphur dioxide.

Sulphur dioxide, when present in air to the extent of 15 to 20 per cent., has little or no effect on dry fabrics.

Coloured materials are not usually affected unless moist, and in this case bleaching occurs to an extent depending on the nature of the dye.

Coloured silks of various shades, coloured cotton and flannels, have been kept for five hours in an atmosphere containing 15 per cent. of SO_2 without being appreciably affected.

Food-stuffs generally are not affected.

Common paints are not, as a rule, appreciably affected.

Dry air containing sulphur dioxide has little or no action on dry metals, but if the atmosphere is moist a superficial corrosion occurs with such metals as iron, steel and copper.

In order to ascertain the fire-extinguishing properties of SO_2 mixed with air, a number of experiments have been made with ordinary air containing different proportions of the gas, a lighted taper being used as an example of a rapidly burning material. The results show that in the presence of 7 per cent. of SO_2 the flame was at once considerably diminished and ultimately extinguished; with 8 per cent. it was almost instantly extinguished; whilst with 8½, 9 and higher percentages the extinction of flame was immediate. These results were obtained with sulphur dioxide mixed with air. If sulphur is burned in the air to form sulphur dioxide at the expense of some of the oxygen present, the flame extinction effects are obtained with smaller percentages of sulphur dioxide.

The experiments described above on the action of air containing SO_2 on coloured fabrics and metals have also been made on the large scale in closed rooms into which the gas in the proportion of 10 to 15 per cent. was admitted from the Clayton generator. The same results were obtained, the coloured fabrics were unaffected, whilst bright metals—iron, copper, brass, etc., were only superficially attacked.

Experiments with fire extinction on the large scale gave the same satisfactory results as those recorded above, burning naphtha being employed in this case as well as burning straw and wood.

The Clayton generator which I have seen in action is an economical and efficient method of producing a regular current of sulphur dioxide, cooled to the temperature of the air by an ingenious arrangement before issuing into the atmosphere.

From laboratory experiments and trials on a large scale, I am of opinion that the admission of about 10 to 15 per cent. of SO_2 into air for the purpose of disinfection can be employed without harm to any ordinary substances, except bright metals, which are superficially attacked. On board ship, however, all large surfaces of iron and other metals are usually protected by paint (as in the bilges), and would, therefore, not be affected. In other cases metals should be protected by a temporary coating of varnish or other impermeable material.

I am satisfied that the introduction of from 7 to 10 per cent. of sulphur dioxide into air by means of the Clayton apparatus is an efficient means of extinguishing fires.

Mr. D. ANDREW said—The interesting paper we have had from Mr. Heck brings forward a subject which has been frequently under discussion by those connected with shipping and the carriage of oversea goods, viz., a prompt and effectual means of preventing or overcoming a fire at sea, a subject which I consider has not received the consideration it merits.

We have before us the great strides made in shipping. Since the days of sailing vessels carrying emigrants to our Colonies, to the present time, with our magnificent steamers, to whom distance is no consideration, little has been done towards providing means on board vessels to fight what I would say is the most terrible disaster men have to contend with at sea.

Mr. Heck mentions several of the means tried in years gone by to accomplish this, but they were not a success, and we were left with the only means at hand, viz., "get the hose along and start the donkey," and in many cases this would be effectual, provided the fire was in the vicinity of the line of hose. Of course there is a plentiful supply of water, but the difficulty, as Mr. Heck mentions, is to get the water to the seat of the fire, and this was my experience during my sea-going days with a general cargo. It was impossible to go into the hold, owing to the smoke and fumes from the burning cargo, in order to locate the fire; so after nearly suffocating the crew in their efforts to break out the cargo, there was nothing for it but to pump water into the hold, until it rose sufficiently high to reach the fire. Fortunately, in this case, the fire being below the 'tween decks, the vessel floated with the additional weight, and the fire was a small matter in comparison with the damage by water. It is doubtful if this course could be adopted in all cases, say with a deep loaded vessel and a fire located near the deck.

At the close of the "seventies" and early in the "eighties" fires in steamers carrying cotton from the Southern States of America were of frequent occurrence, and the fitting of pipes for flooding the holds with steam became general. This was effectual in putting out a fire, but the steam becoming moist damaged the cotton, and also gave rise to another danger, spontaneous combustion, through the heating of the wet cotton. During 1881 I was engaged in several cotton fire cases in the Southern States, and I found that fire extinguished by water is very liable to break out again when exposed to the air. I may quote one case. A steamer put into Savannah with a cargo of cotton on fire, and it was found impossible to get it under except by pumping the main hold full of water, the vessel being beached for the purpose. The hold remained full for 24 hours before being pumped out, and the cotton discharged. During discharging, an engine belonging to the fire brigade had a hose turned on the burned bales when landed, as they were continually taking fire, until all the burned portions were removed, and the wet bales were spread out separately to prevent heating and probable combustion. Esparto grass is a cargo that will readily heat when wet, and liable to fire, particularly any portions that have been burned.

I witnessed the experiments at Wallsend with the sulphur

dioxide apparatus, and the effect on a good strong fire was instantaneous. It is a thoroughly effective fire-extinguisher, and will greatly minimise the danger from fire in cargoes I have mentioned. But supposing a cargo of cotton or grass stowed closely in a ship's hold, which is invariably done—would the gas driven into the hold by a fan penetrate through the cargo in such a manner as to come in contact with a fire caused by the friction of the bales, which is a generally accepted theory as a prolific source of fires in cotton and grass cargoes due to the motion of the vessel?

Mr. Heck states that a certain percentage of sulphur dioxide will kill rats. What percentage would be dangerous to human life, supposing it was used in case of fire on board ship, and escaped from the hold, say, into the passengers' berths or the engine room? And would cargo so treated retain the gas to an extent to make it uncomfortable for the men discharging the cargo? Again, would cotton, grass, or any like cargo that had fired and been extinguished by this gas be liable to break out again on fire, such as is the case when extinguished with water, or is it an effectual extinguisher?

The introduction of this apparatus on board shipping is a long stride in the direction of safety from fire, and also represents an enormous saving in damage to cargoes from the unsatisfactory, antiquated and wasteful system of putting out a fire with water. It is, I consider, a very interesting subject for an Institution such as ours, and one which, I hope, will bring forward a good and strong discussion.

Mr. Henry Withy—I cannot claim to have had the experience Mr. Andrew has had, and I am glad I have not. I think a fire on board ship is not a pleasant companion. I made one or two notes during the reading of the paper which I propose to trouble you with. Mr. Heck says it is stated that insurance companies and underwriters have given preferential insurance rates where this apparatus is fitted. It would be very interesting to know to what extent such rates have been reduced. I believe the general experience is that underwriters are not very ready to reduce their rates, and do not give credit for what is done. It is generally claimed that twin-screw ships are safer than single-screw, yet I believe underwriters ask a higher premium, because

there are two engines to look after instead of one. I would like to ask how soon it is safe to enter the hold after the apparatus has been in use. I take it that it would not perhaps be wise to enter the hold for a while, but that the apparatus should go on pumping and clearing the gas from the hold. I have inquired, too, about the ventilators. Apparently, as the gas is so heavy, it does not matter about ventilators, as the gas will fall to the bottom. The great point is the cost. I do not know what sized ship this apparatus will fit.

Mr. J. B. ADAM (a visitor)—Any ship.

Mr. WITHY—I am afraid not. The more compartments there are the larger you will want the apparatus. The question of the cost of the apparatus is really very important, because it is exceedingly difficult to persuade shipowners to fit up any extra apparatus on board ship, especially an apparatus that is not likely to be used frequently. I quite agree that such an apparatus as this might be worth fitting in passenger vessels, but I doubt very much if owners would quite see their way to do it unless the shipbuilder paid for it. That is my usual experience.

Mr. JAMES STEWART—I think we are indebted to Mr. Heck for bringing a subject like this before the Institution, not only on account of the scientific interest attached to it, but more especially in view of the importance of the object aimed at, namely, the saving of life and property at sea. This importance seems to go on increasing with the increase in the size of our vessels and, therefore, in the number of lives and the value of the property at stake in ship and cargo. And there is another matter: I do not know if I am right or not, but my impression is, and it is gathered from reading the shipping intelligence columns of our daily papers, that ship fires are of more frequent occurrence now than they were even a few years ago; either that or they are more regularly reported. Perhaps some of our underwriter friends will be able to enlighten us as to this.

Mr. Heck has enumerated the various methods that have been adopted for fire-extinguishing on board ship. I would refer to two of these, namely, the steam and the sulphur dioxide. The

steam system has been for a good many years in use in American passenger vessels, where the fitting of it is enforced by American law, and that law still holds good. The system consists of a number of perforated steam pipes leading through the vessel's holds and compartments, with the necessary valve connections on deck. I have no actual data as to the efficiency of this plan of fitting the pipes, but I happen to know of one English cargo vessel fitted for steam fire-extinguishing in a very cheap and simple way. As the vessel was to make several consecutive voyages with cotton from Savannah to the Continent, the owner took the precaution of having small branch steam pipes fitted from the winch pipes on deck, simply leading one pipe to each hatch coaming and no further. It so happened that on the first voyage fire broke out in one of the holds shortly after leaving Savannah. Steam was turned on at once and the captain told me afterwards that it kept the fire so well in check that he would have had no fear himself of proceeding on the voyage, but considering the interests involved, he did not take the responsibility. Instead, however, of putting in to Newport News, which was within one day's steaming distance, he went on to the preferable port of Halifax, steaming for four or five days without experiencing any difficulty. On arrival at that port the hatches were opened and discharging of cargo commenced in order to get at the seat of the fire, but work had not proceeded far when the fire broke out afresh; the hatches were then closed down and steam turned on again; but this attempt failed in the same way, and eventually the fire was extinguished by flooding the hold with water. The result of all this was a considerable amount of damage to cargo by fire and water as well as serious loss of time to the vessel.

With regard to the sulphur dioxide system as described by Mr. Heck, I had the privilege of witnessing the experiments at Wallsend, as well as similar, but more elaborate, experiments some time afterwards at the East India Docks, London. But what was even more interesting was a demonstration I witnessed a few weeks ago on board a vessel fitted with this apparatus. For the purposes of the demonstration the poop, which was empty at the time, was chosen, and in this compartment some wood soaked with paraffin was placed: this was set fire to, the doors and other openings closed, and the machine started. I may mention that some live rats, which had been brought on board in cages for the

purpose were also placed in the compartment. After the machine had been kept working for about an hour the doors were opened, and it was found that the wood was only slightly charred, showing that the fire had been extinguished almost at once, while all the rats were found to be dead. An indispensable part of the apparatus is the cooler which is attached to it, and the experiments have proved this conclusively. If the compartment is opened too soon, before the fire is quite extinguished, the access of oxygen sets it away again at once, but if the compartment is kept closed long enough the machine can circulate the air until the temperature is thoroughly reduced. This would point to the machine being useful as a means of preventing as well as of extinguishing fire, and I understand that with this in view one sailing vessel was fitted with it before proceeding on a long voyage with a cargo of coal liable to spontaneous combustion. I have no particulars of the result except that the vessel reached her destination in safety. Mr. Withy has called attention to the insurance question, and this is most important, because it is quite evident that shipowners will not go to the expense of fitting the apparatus unless their underwriters make sufficient allowance to induce them to do so. But the experiments that have taken place seem to have had their effect, for several owners have had vessels fitted, and reduced premiums have been granted in consequence. I know of one case at least where this reduction amounts to five shillings per cent. on the insured value of the vessel. That is to say, if the value of the vessel is £40,000 the underwriters return £100 at the end of the insurance year, provided there is no claim for fire damage during that period. It seems to me that those most interested in this matter are the underwriters on cargo, and although I do not know the facts about this, I am given to understand that in some cases important preferential rates have been granted. Whether an apparatus of this kind comes into general use or not remains to be seen, but at any rate it claims the serious attention of shipowners and underwriters.

Mr. J. B. Adam (a visitor by permission of the President) said—I am very glad to be here to-night, not only to pay respect to my friend Mr. Heck, but I am obliged to him for the able way in which he has produced this paper. As regards fire extinguishing at sea it is a thing I have often thought

about, and especially this year, when I took a trip to Australia, I thought what a dreadful thing it would be if anything of that kind happened, as there were 940 souls on board, and there were not boats enough to carry away half that number. But, happily, nothing did occur. I first saw the Clayton fire machine in America in 1900. The first ship that went away was under the guidance of our friend Mr. Stewart. It went to Galveston, and there the captain had instructions to fill his hold with gas the moment she was laden. Every compartment was filled with gas, so that it was impossible for any fire to take place during the voyage. This is in reply to my friend Mr. Andrew. He asked if it is possible, supposing a cargo of cotton is on fire in the middle of the hold, for the gas to penetrate into it. Not only will the gas penetrate into it, but the fire itself makes a vacuum, and draws the gas to the very seat of it and puts it out. But when a careful captain at the starting point fills his compartments no combustion can take place at all. If it leaks, as it may in every compartment, there is no harm, because in four or five days if the gas is found to have evaporated to any extent all you have to do is to put on the machine and put a little more gas into the compartment, and therefore you can keep your compartments charged during the whole of the voyage. As to its use on board sailing ships. One ship, called the "Eastern Monarch," loaded with a cargo of a combustible kind of coal, sailed from Birkenhead bound for Pisagna. When on the voyage the captain found the temperature of his hold rise to a large extent in crossing the line, he put on the machine, and by circulating the air that was in the hold, he soon had the temperature down, and he said he would not sail again without the machine. It is now a pet thing with him. On board sailing ships it is a very simple matter indeed. On board the ship Mr. Stewart referred to, they had a common leather hose attached to the end of the pipe on the ship's deck. It is a great thing at sea for the comfort of the sailors to be able to fumigate all the compartments of any ship and destroy all vermin which infest them in hot regions. The gas will kill them all, and give comfort to those on board, and in addition to that the cabins can be fumigated where mosquitoes abound. The most interesting experiment made to prove the value of the machine in disinfecting was on the

arrival of a vessel called the "City of Perth" at Dunkirk from Calcutta. She had a valuable cargo and she had plague on board. Of course, the Frenchmen immediately said, "Go away; we won't have you at all. If the cargo must come here you can go to quarantine island and discharge it there and come back with a certificate from the doctors at the quarantine station." The cargo was a valuable one, belonging to a party in London, and they were exceedingly anxious to get delivery of it. They applied to the Clayton Company in London, who saw Dr. Williams, the sanitary inspector in London, and he, after a great deal of persuasion, allowed this vessel to come from Dunkirk to the quarantine grounds below Gravesend to be fumigated. The Company have in London and Liverpool a steam barge, or rather a little tug, with two of these machines on board for the purpose of disinfecting. This tug went alongside the vessel, and, by order of Dr. Williams, the first thing they did was to clothe the tug men in oilskins, and they disinfected every compartment, including the sleeping and eating compartments, and drove the rats into the holds. After that they disinfected the whole of the cargo, and killed all the vermin and rats on board of the ship. The cargo was then discharged into lighters and re-loaded for Dunkirk, and there was not a farthing of claim upon that valuable cargo. About 150 rats killed by the gas were found while discharging the cargo. That is one point in which this apparatus comes in. It is known in this and other countries that rats carry plague. When I was in Sydney, the plague happened to be there. Luckily I came from New Zealand, and I got in without any quarantine. When I got there I said, "What means have you here for disinfecting ships coming from Calcutta with horses, and from the Cape with troops and horses?" They had none at all. I spoke to some of the influential people there and put this matter before them, and said the Company before mentioned could send them a machine. They said, "Send the machine immediately; we want it here badly." I cabled, and the machines came as fast as possible. A ship came in with troops and horses from the Cape full of rats, etc. They had a little tug which was put alongside and sulphur gas was poured into the ship's hold and all vermin on board were killed. I mention these facts because they are of interest to you who have heard the paper read by Mr. Heck. The patent machine is simple.

It is not costly, and as regards the insurance, I may say when my firm took in hand to experiment or to put these machines on board vessels it was only natural that we wanted a way whereby we should see some benefit in return; and the men who chartered the cargo got the benefit. The underwriters said, "Well, we will recognise that, and we'll only be too glad to return you 5s. per cent. on the value of any steamer that may be insured, provided there is no claim for fire during the currency of the policy. In the case of another vessel the insurance was 60s. without the machine, and 55s. with it. I do not think there is anything else that I can enlighten you upon. Just as I told your President, I came here with the intention of listening to Mr. Heck whose views I, as a member of Lloyd's Committee, value very much indeed, and I know that whatever Mr. Heck says he believes to be perfectly true. I am very much obliged to you, Mr. President, for allowing me to say these few words to the members. It is more of an owner's matter than that of a shipbuilder. It is for the shipowner to take the matter up, and if he sees it to his advantage no doubt he will do it.

Mr. E. Wilson said—I should like to thank Mr. Heck for his paper, and also to thank Mr. Andrew for having gone into the matter by enquiring about the efficiency of the machine in penetrating a cargo like cotton or grass. Mr. Adam explained that it is quite possible to fill the whole hold with gas, and thus prevent any fire. Once it was my experience to be on a ship carrying a cargo of iron pyrites which heated and actually produced sulphur-dioxide gas. The first intimation we had of it was by the firemen and trimmers saying it was impossible to work on account of the suffocating fumes of sulphur. We soon found sulphur dioxide was an unpleasant thing. Our experience was pretty much the same as that of the rats. We were reduced to the extremity of going every five minutes into the bunkers, as it was impossible to work any longer there with the iron pyrites giving off sulphur. Thus it appears to me in regard to this apparatus that one essential for the safety of the people on board is that the bulkhead must be perfectly tight. If it gets to the other side of that bulkhead it is very soon impossible to work in the ship. Of course cargoes of this nature are not common. I am glad that is the only one I ever had any experience of, and it

appears to me this apparatus will be very objectionable unless the bulkheads are perfectly tight. I should just like to ask Mr. Heck if he can give any satisfactory method of dealing with a cargo which gives off sulphur dioxide to prevent an uncomfortable experience for everyone on board.

Mr. ADAM—With your permission, Mr. President, I would just like to say that all ships are expected to have their bulkheads tight. Any gas that may exude through a bulkhead will hurt no man, because it won't come through in such volume as to keep him out of the stokehold. It never has done yet. If it comes through at all it is in a very small supply. In our experience there has been no danger whatever to the people who were stoking the vessel or who were engaged in the fumigation of her.

The PRESIDENT—The practice of the Institution prevents us moving a vote of thanks to Mr. Heck for his paper to-night but at all events we feel we owe him one. I had the honour the other night, as representing this Institution, to be present at the annual dinner of the Electrical Engineers. They paid this Institution the compliment of classing it with the learned societies. We have learned to-night that the new system of treating fire is also useful in killing rats, and I have been most interested in finding in the room here a report which, to a learned society such as we are, is very interesting. It is proved also that this system has a very serious effect upon microbes. A learned society must bring the word microbes into its discussions somehow or other. In France, Dr. Calmette, of the Pasteur Institute, has made certain experiments with regard to the destruction of microbes, and the results have been perfectly satisfactory. He says:—"We had prepared, at the Pasteur Institute of Lille, fresh cultures of typhoid fever, cholera and plague, with which we had saturated small strips of flannel. These strips of flannel, thus artificially infected, were placed, some dry, others moist, in cylindrical glass tubes of 30 millimetres diameter (1·18 inch) previously sterilised, open at both ends, and stopped with cotton." He goes on to describe certain other experiments, and they found the Clayton system was perfectly satisfactory in destroying all these interesting animalculæ. I am told that it is usual for these discussions to

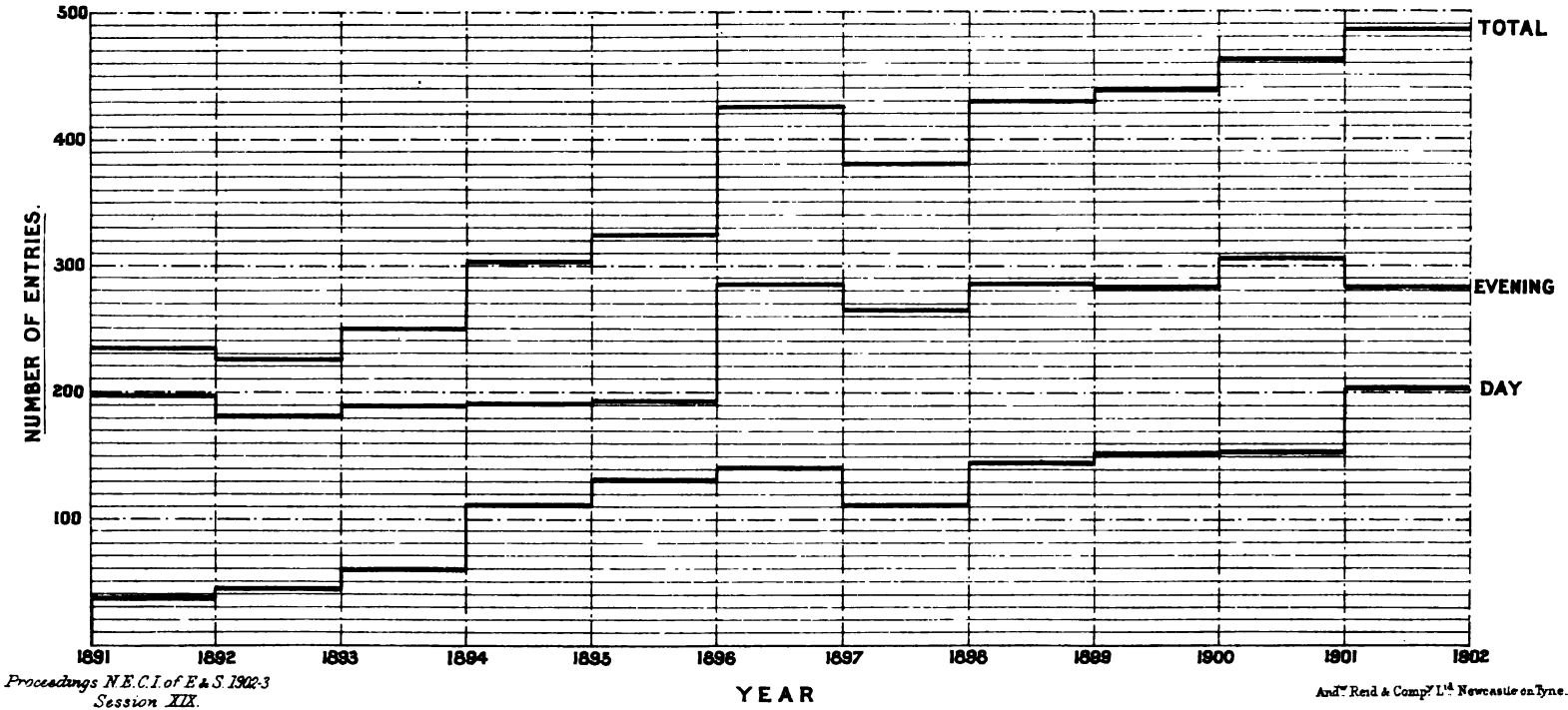
be adjourned until the next meeting. I hope that those who have time and sufficient knowledge of the matter will add to the interest of the paper by continuing the discussion at that meeting. We are prevented from according a formal vote of thanks to Mr. Heck, but we do it informally now. Mr. Heck's paper gives a good condensed account of the history of fire appliances at sea. He also describes a new one. I think the paper is already very complete, still, if he would reply to one or two questions, and give the dimensions, cost, and any other such data I am sure we should all be obliged to him.

The meeting then dissolved.

DURHAM COLLEGE OF SCIENCE.

STUDENTS ATTENDING THE DEPARTMENT OF ENGINEERING AND NAVAL ARCHITECTURE.

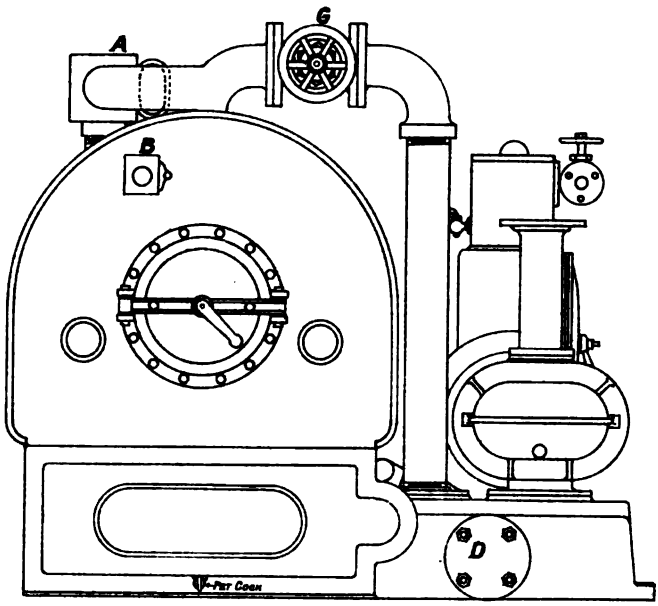
DEPARTMENT INSTITUTED IN 1891.



Proceedings N.E.C.I. of E. & S. 1902-3
Session XIX.

And.r Reid & Comp.y L.td Newcastle on Tyne.

FIGURE 3.



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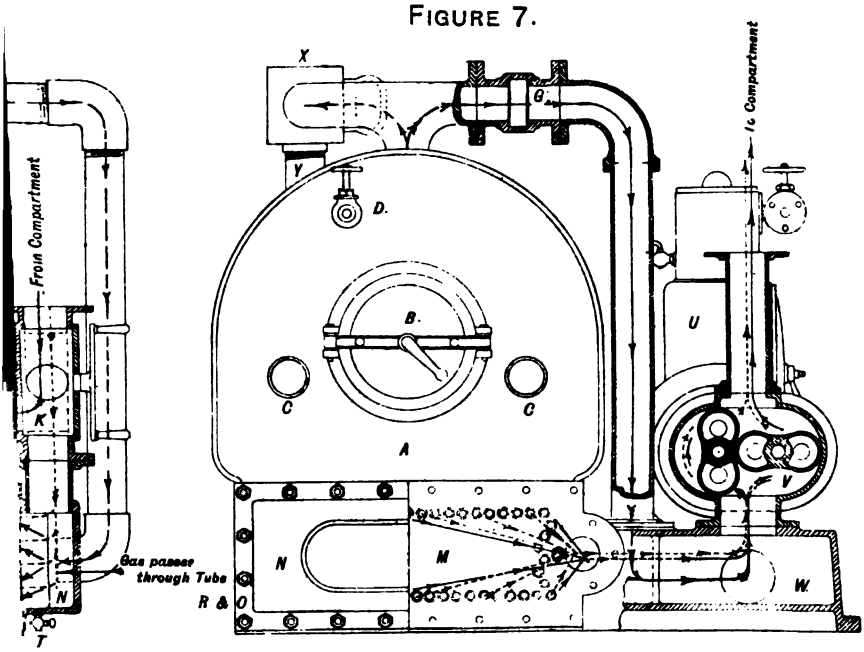

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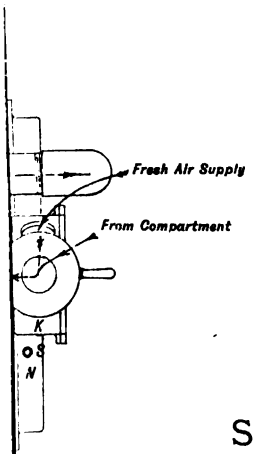


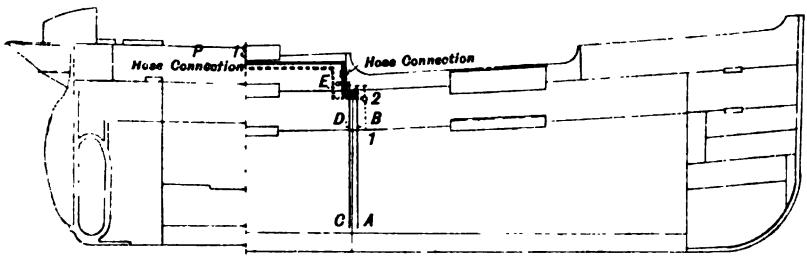
GENERAL ARRANGEMENT

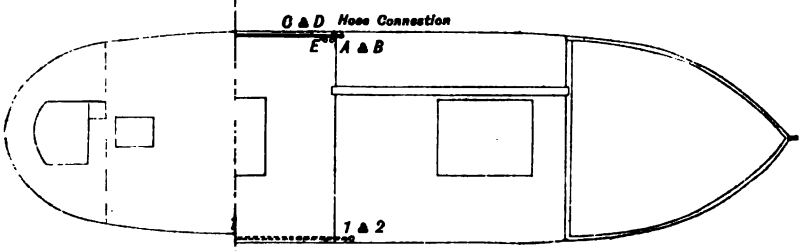
OF

SULPHUR DIOXIDE GENERATOR.

TYPE A.

And^w Reid & Comp^y L^td Newcastle on Tyne





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A No. 1 Lowe…
B „ „ 'Twee…
C „ 2 Lowe…
D „ „ 'Twee…
E Upper Deck…
F Auxiliary B…
G Port Bunke…
H Starboard …
J No. 3 Lowe…
K „ „ 'Twe…
L Upper Dec…
M No. 4 Low…
N „ „ 'Tw…
P Poop

REFERENCES.

…BLE LINES INDICATE 2½" PIPE SHOWN THUS ——————
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…CHARGE PIPES SHOWN THUS ——————
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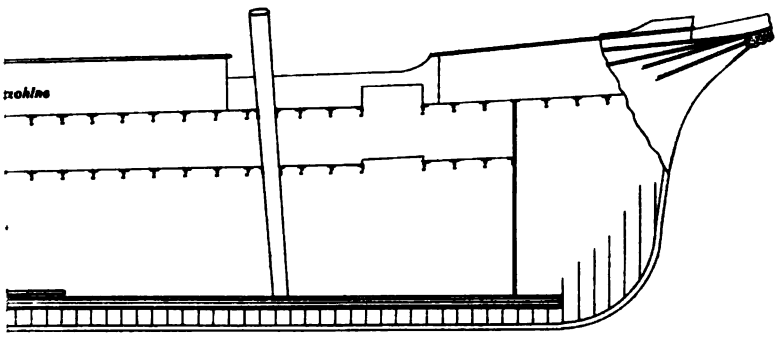
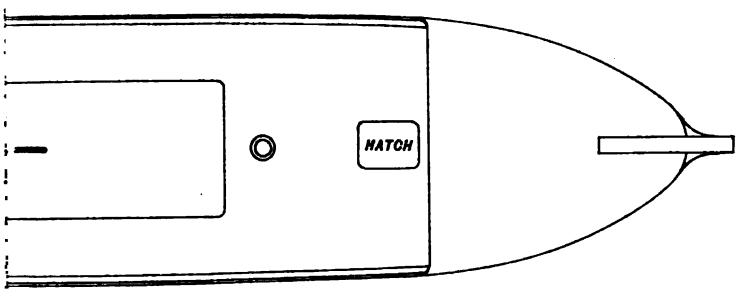
EL.





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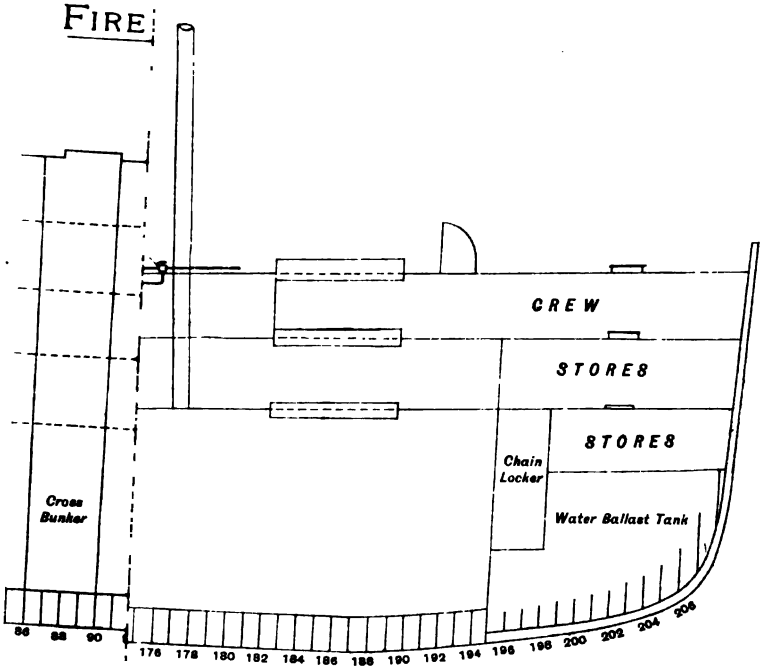
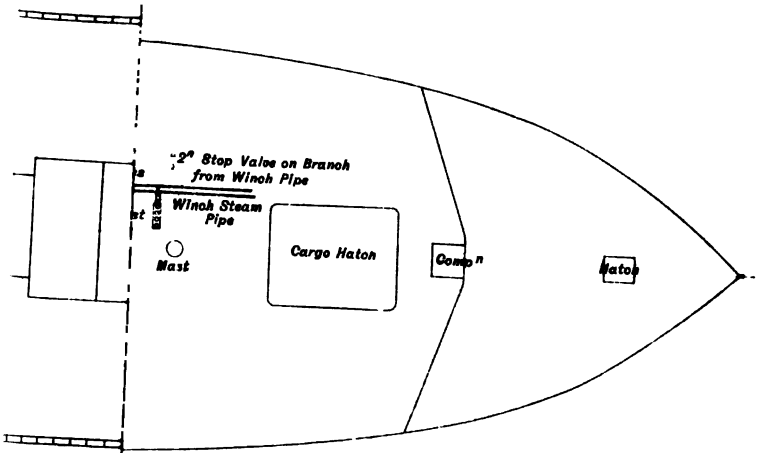
J. H. Heck

PLAN

FIRE





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NORTH EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.

NINETEENTH SESSION, 1902-1903.

PROCEEDINGS.

THIRD GENERAL MEETING OF THE SESSION, HELD IN THE LECTURE HALL OF THE SUNDERLAND LITERARY SOCIETY, FAWCETT STREET, SUNDERLAND, ON FRIDAY EVENING, DECEMBER 12TH, 1902.

W. H. DUGDALE, ESQ., VICE-PRESIDENT, IN THE CHAIR.

The CHAIRMAN read a letter from the President (John Tweedy, Esq., J.P.), stating that he had just returned from the Continent and was suffering from a severe cold, in consequence of which he regretted he was unable to be present at the meeting.

The SECRETARY read the minutes of the previous meeting held in Newcastle-upon-Tyne on the 21st November, 1902, which were confirmed by the members present and signed by the Chairman.

The Chairman appointed Mr. John H. Heck and Mr. J. Hamilton Gibson to examine the voting papers for new members, and the following gentlemen were declared elected:—

MEMBERS.

Alexander, Francis H., Naval Architect, Durham College of Science, Barras Bridge, Newcastle-upon-Tyne.

Crozier, Thomas W., Ship Draughtsman, 43, Beaconsfield Street, Blyth.

Mudie, James Herbert, Marine Engineer, 101, Park Road, Wallsend-on-Tyne.

Phillips, Joseph, Shipbuilder, 15, Park Avenue, Wallsend-on-Tyne.

GRADUATES TO MEMBERS.

Bowerbank, Albert W., Engineer, 52, Victoria Avenue, Whitley Bay, Northumberland.

Burgess, Norval Henry, S. Draughtsman, 46, North View, Heaton, Newcastle-upon-Tyne.

Donaldson, Henry B., Shipbuilder, c/o Messrs. Sir Raylton Dixon & Co., Cleveland Shipyard, Middlesbro'-on-Tees.

Waddingham, William H., Engineer Draughtsman.

GRADUATES.

Bullen, Harold, Engineer, 15, Caroline Street, Jarrow-on-Tyne.

Collin, Albert H., E. Draughtsman, c/o Messrs. John Lynn & Co., Ltd., Pallion, Sunderland.

Coull, Thomson Bankhead, E. Draughtsman, South Preston, North Shields.

Mackley, John Robert, E. Draughtsman, 97, Enfield Road, Elswick, Newcastle-upon-Tyne.

Matheson, Ian Ross, Shipbuilder, The Clack, Hebburn-on-Tyne.

Phillips, Alexander, Ship Draughtsman, 15, Park Avenue, Wallsend-on-Tyne.

Readhead, Stanley, Shipbuilder, Westoe Hall, South Shields.

The discussion on Mr. J. H. Heck's paper on "Fire Extinguishing Apparatus" was resumed.

Mr. J. HAMILTON GIBSON read a paper on "Large Stop Valves for High Pressure Steam."

RESUMED DISCUSSION ON "FIRE EXTINGUISHING APPARATUS FOR SHIPS."

The discussion on Mr. John H. Heck's paper on "Fire Extinguishing Apparatus for Ships" was resumed.

Mr. E. C. CHASTON said—It is with some diffidence that I attempt to discuss Mr. Heck's paper on "Fire Extinguishing Apparatus for Ships," but since he read it we have had two object lessons in the cases of the s.s. "Glenisla" and s.s. "Tartar-Prince," demonstrating the value of having ships fitted with the best possible means or methods for dealing with outbreaks of fire.

The present everyday manner of extinguishing fires by steam has three special features to recommend it, namely:—It is very cheap in first cost, very simple, and invariably at hand immediately when required. I know of at least two cases where the extinguishing of fire (cotton cargo) by steam was very successful so far as putting the fire out, but the steam jet had to be kept on to the hold where the fire had been for practically one-third of the passage from Galveston to Havre, and as Mr. Heck has pointed out, the cargo suffered considerably from the effects of the steam. Mr. Heck, in his plan (Fig. 11, Plate VI.) of steamship pipe arrangement, does not show where he places his machine (or sulphur dioxide generator). Nor yet does he give any approximate cost of installation complete in all details—machine, pipe arrangement, etc. From the measurements given in Figures 1 and 2 (Plate II.) I find there is a measurement capacity of 9½ tons absorbed or taken up by the machine alone, that is, including a reasonable space to get round the machine, should the machine be placed in any part of the vessel where cargo could be carried, such as under the long bridge or bridges of the present type of tramp steamer.

It is very pleasing to find papers dealing with the economics of shipping property in times like the present, where the main points at issue are to reduce risks and consequent claims on

underwriters with the ultimate result of keeping down insurance premiums, and also to minimize the risk to life and limb. I hope Mr. Heck will further enhance the value of his paper in his reply by giving some details as to cost of fitting installation complete, upkeep, and the names of vessels already fitted.

I think we, the members of this Institution, owe Mr. Heck our best thanks for the valuable information which has been put before us.

The SECRETARY read the following communications:—

LIVERPOOL, 10*th Dec.*, 1902.

DEAR MR. DUCKITT,

I am sorry I shall not be able to come to the meeting on Friday, 12th inst., owing to business here, but am sending you four lantern slides, illustrating the fire appliances on board the school-ship "Conway," which were arranged under my supervision, at the request of the Committee, about three years ago.

Mr. Heck's interesting paper deals chiefly with the SO_2 apparatus, which doubtless may have more general application than the one I am about to describe, and which was designed to meet a somewhat exceptional case.

Slide No. 1 shows the "Conway," a vessel constructed of wood throughout with iron knee-bracings, etc. The total destruction of the "Clarence" and other ships of this type by fire, which members will doubtless recollect, demonstrates the necessity of an ever-ready means of extinguishing fire at its first outbreak. Damage done by water to property on board would of course be out of consideration, compared with the safety of the two hundred persons or more on board.

Slide No. 2 (Plate VII.) shows the general arrangement of the installation for electric lighting and fire extinction. There existed on board previously an electric lighting arrangement, consisting of an oil engine, dynamo, and storage batteries to the amount of 200 16 candlepower lamp hours. This being found insufficient and unsatisfactory, the electrical storage capacity was doubled and a steam boiler, engine, and larger dynamo were fitted on board for electric lighting.

For fire extinguishing purposes, a set of 3-throw geared pumps with 4-inch sea suction and 3-inch delivery was supplied

by Messrs. Ernest Scott & Mountain, and so arranged on board that they could either be driven off the storage batteries by means of an electric motor, or connected to the 16 horsepower steam engine direct, by simply shifting a belt.

In practice the pumps are left connected to the motor, which can be started at a moment's notice, independently of there being steam handy. The pumps can deliver either to a large tank on the forecastle, of 4,500 gallons capacity, or direct to the deck pipe line which has hose couplings on each deck, as shown on Plate VII.

A small duplex feed donkey also delivers into the fire pipe line, so that there are four means of feeding the fire-hose:—

(1) The water tank, which is raised 7 feet above the deck and is always ready for emergency.

(2) The triple pumps connected to the electric accumulators, which, if fully charged, would pump about 500 tons of water with a head of 50 feet, or a smaller quantity of water according to the amount of electricity used in lighting since last charged.

(3) The triple pumps driven by steam. The boiler is kept with fire banked, when not in use driving the dynamo, so that full pressure could be got up in a very short time.

(4) The small duplex steam pump.

Slide No. 3 (Plate VIII.) shows the engine and dynamo room, with the pumps in the background, and electric starting switch on the bulkhead. The electric motor is not visible in the photograph, being hidden by the pumps.

The engine fly-wheel, dynamo pulley, and pump pulley, are all in line, so that the dynamo belt can be removed and the pump driving belt slipped on in its place.

Slide No. 4 (Plate IX.) shows the arrangement of storage batteries, which are of E.P.S. type.

The fitting up of the steam and electrical installation was carried out by Messrs. Boothroyd, Hyslop & Co., of Liverpool, who also made the new dynamo and rewound the old dynamo to act as a motor.

In conclusion, I need hardly point out that comparatively few vessels afloat are fitted with storage batteries, but when they happen to be so, as in the case of the cadet ship "Conway,"

the installation seems to lend itself to a very handy means for fire extinction, as the pumps can be switched on full power at a moment's notice.

In order that the pumps, etc., may always be kept in good order, fire drill is engaged in every week, and the pumps are also regularly used for washing decks, so that there is no fear of things getting out of order through want of use.

Yours faithfully,

J. DENHOLM YOUNG.

52, FERN AVENUE, JESMOND, *Dec. 12th*, 1902.

DEAR MR. DUCKITT,

I have read with a great deal of pleasure, the paper on fire extinguishing apparatus. The author, in presenting this subject to the North-East Coast Institution, has succeeded in putting into a nutshell what, from the point of view of importance, could be expanded into many more pages, and has created a good deal of discussion on a too often neglected subject.

The question of fire extinguishing as applied to ships is one of very great importance when one considers the possibility of disaster, not only to cargo and the vessel itself, but to the living freight also; and one views with no little surprise the fact that while so many factors of safety have been introduced into ship construction, yet the question of meeting the demands consequent on a conflagration on board ship has received comparatively so little attention hitherto.

There seems to be two main features to be considered in connection with this subject:—(1) To fit out the vessel, and more especially in those of a certain type, with wood of a non-combustible character, as pertains in Admiralty ships, so that the destructive effect of a fire may be so far reduced to a minimum; (2) to place some efficient means on board to cope with a fire quickly and effectively when the occasion may arise.

The fitting of fire apparatus on board is looked upon by a great many owners of ships with a good deal of discredit; it is in a measure considered as an encumbrance likely to be seldom if ever used, expensive to fit, and to some extent taking up space in the ship which could be better and profitably utilised. Be this as it may, there still remains the fact that such a precautionary measure is really an insurance on the vessel, which,

in an emergency, would probably save much expense to the shipowner and the underwriters, to say nothing of the vessel's consequent delay and loss to the people to whom the cargo is consigned.

Water and steam may be put aside as comparative failures, failures due to slowness of action and monetary loss brought about by the damage done to certain cargoes which may not have been touched by the fire itself. There are many gases which, as non-supporters of combustion, could be used more or less effectively, but the difficulty and expense of making these on the spot prohibit some from consideration. CO_2 and SO_2 are probably the best agents; and of these SO_2 is preferable for various reasons. Even this latter is not the ideal product one would desire, and with certain types of cargo would entail damage almost, if not quite, as far reaching as the fire itself, *e.g.*, cargo consisting of fabrics containing vegetable matter; oil, foodstuffs, etc., while in the case of meat-carrying vessels there would by condensation be a deleterious effect, this gas condensing at 8° C.

On the whole, the Clayton fire extinguisher is probably the best, simple in construction and in generating the gas, and practically effective in its action. In respect of this latter, and of the subject as a whole, I think the author deserves the best thanks of your Institution for the concise way in which he has placed a very important subject before you.

Yours faithfully,

BERNARD C. LAWS.

Mr. J. B. EVANS (a visitor, by permission of the Vice-President) said—With reference to Mr. Heck's paper on this system of fire extinguishing I have had the opportunity of carrying out rather a considerable number of experiments with it, not only as a fire extinguisher on board a vessel, but also as an appliance for germicidal work. By that I mean fumigation and the killing of vermin. I think first of all I had better speak of its fire extinguishing properties. On board a vessel it would approximately take, to fill a hold with a sufficient percentage of gas to certainly stop combustion in any cargo—except that which carried its own oxygen, such as nitre or gunpowder, but any ordinary inflammable cargo like cotton

or hay—about three-quarters of an hour's time. It depends, of course, on the size of the hold, but taking an average, in three-quarters of an hour sufficient gas would get into the hold to prevent combustion. It possibly would not be safe to open the hatches, but no more combustion would be going on. Mr. Chaston spoke about where this machine would be placed. I have seen it placed in various positions on board ship. It is usually put on the platform where the steering gear goes, so that it is handy to the engineer. He has to work it, and it is generally put in some position where he can get at it quickly. There is no fear about it not extinguishing fire, because I have seen it do so many times. In cases of bales of straw saturated with petroleum, and cotton saturated in the same way, the fire is out in three minutes. It would not be safe to open the hatches of a vessel, with say a cargo of hay which had been on fire, until the circulation has been continued for some considerable time, as owing to the property which carbonised material has of absorbing oxygen rapidly, there might be danger of re-ignition. This is one of the principal features of the apparatus as I understand it. After the hold or compartment has been filled with gas the whole place inside has to be cooled down, and fresh air admitted gradually to prevent this re-ignition. In the case of a vessel carrying a cargo at sea, if it was bad weather or anything like that, they would simply fill the hold with gas and wait till they got to port before they commenced circulation or cooled the hold down. I think the only other point of particular interest is its germicidal qualities, that is, the ease with which a vessel can be kept free from all kinds of vermin. Bugs, fleas, cockroaches, rats, etc., are killed very quickly. I was present at an experiment in Paris to see how long it took a 10 per cent. solution of this gas to kill the eggs of cockroaches and weevils, and it was found that they succumbed after about a quarter of an hour's exposure to the gas. Cockroaches and rats are killed in about five minutes. Then it does no damage at all to any cargo; that is, any dry cargo. I do not say it would not do damage to fruit, but ordinary dry cargo is not affected. I have drunk tea which has been in the gas for twelve hours, that is, before it was brewed, and there was no foreign taste in it at all. Nearly all other foodstuffs are untainted by the gas. I may also mention

the case of the "City of Perth," on board which I happened to be when she was fumigated. That was a vessel supposed to go to Dunkirk with a mixed cargo from India. They had plague on board. They entered the docks, and the French sanitary authorities asked, "Have you got an illness on board?" They said they had. They found it was plague, and the authorities sent the vessel out into the roads and said they would not take the cargo in Dunkirk as they had no effective means of fumigation. The vessel came on to London and the Clayton people were asked to treat the vessel, which they did. They killed 200 rats, about 100 or 150 of which were plague stricken. The whole cargo was treated with this gas, and it was transhipped from London to Dunkirk, and there has been no claim for damage from fumigation, nor have they had any case of plague on that vessel since the fumigation.

The discussion on the paper was again adjourned until next meeting for Mr. Heck's reply.

ON LARGE STOP VALVES FOR HIGH-PRESSURE STEAM.

By J. HAMILTON GIBSON, Member.

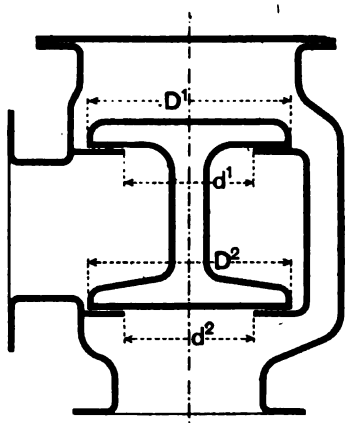
(Read in Sunderland on December 12th, 1902.)

To shut off the flow of steam in a pipe by means of a stop valve appears at first sight a very simple matter. We know by experience that cocks, unless asbestos-packed and of small dimensions, are useless for steam purposes, and we have become accustomed to screw-down valves, having a kind of vague, comfortable feeling that all things are possible in the matter of making a valve tight, given a screw-spindle and a big enough handwheel.

But with the high steam pressures of the present day and pipes of large bore, the making of stop-valves steam-tight is by no means a simple matter, and the writer thinks this Institution may well devote a little time to its consideration and discussion.

Hence this paper, by way of opening up the subject and incidentally to describe some recent experiments and improvements made in this direction by the writer, in conjunction with Mr. Bevis.

As our attention was first turned to double-beat valves, we will deal with that type first in order.



Sketch A.

Double-beat or Equilibrium Valves.

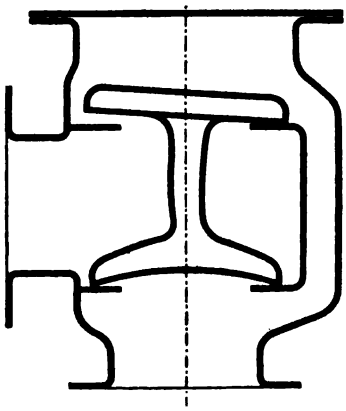
The chronic state of leakage through double-beat equilibrium valves of the type usually fitted as main regulating valves to marine engines is too well known to admit of dispute. It is notorious that these valves when shut often pass enough steam to drive a ship half-speed. This is not surprising when the facts are investigated and understood (see Sketch A). You will remember the old

puzzle of the ideal equilibrium valve. Here it is:—Let $D^1 = D^2$ and $d^1 = d^2$. Suppose all four valve faces absolutely flat and parallel, and the valves to weigh nothing. Query: On steam pressure being admitted, will the valves open or will they remain closed?

Usually out of ten answers, five will say one thing, and five will take the opposite view.

Of course the conditions, being purely ideal, are practically impossible, and a positive answer to the question cannot be given. For to reply that the system is in unstable equilibrium is merely begging the question.

In the first place it is as impossible to make a joint at these two faces of the same piece as it is to be in two places at once, although that is what is being attempted every day in the manufacture of ordinary double-beat valves. In other words, however carefully the two valve faces are fitted, one valve will bear a shade harder than the other, and the system will inevitably leak under pressure.



SKETCH B.

Now imagine the distortion that takes place due to heat when steam is admitted. Temperature upsets all our conditions. The valve-box goes out of shape; the pair of valves become distorted; the seats are no longer circular, concentric, or parallel to each other; the distance between the seats no longer equals the distance between the valves; and the apparatus is bound to leak (see Sketch B).

It may sometimes happen that in small valves with powerful closing gear sufficient force can be exerted to jam the parts together, in which case the lighter the valve can be constructed the better.

Fig. 1 (Plate X.) shows the usual type of double-beat valve drawn from an actual example of light construction. The probable distortion due to heat, and the manner in which these thin valves might "give" to very powerful closing gear is evident.

But light construction is out of the question for large stop-valves to stand high steam pressures. And recognising the futility of employing infinite power to overcome irresistible force, engineers have cast about for other means of manipulating large valves.

Some engineers, with a faith that would remove mountains and a splendid disregard of expense and complication if only the ultimate object can be attained, have tried the infinite power method; as, for instance, in some of the great ocean liners, where the main regulating-valve is actuated by a special separate steam engine driving worm-gearing.

More recently a combination valve and piston has been tried (Fig. 2, Plate X.) in which the steam pressure on a piston was intended to balance the load on the valve. Theoretically this combination appears to be perfect; but there are fatal disadvantages which condemn it in practice.

Passing over the primary defect of its size, due to all the steam having to pass through one valve, we may say at once that all the other defects are the result of distortion of its parts due to heat.

Fig. 2 is a section through a main-regulating valve of this type for the engines of a 15,000 I.H.P. battleship with steam at 250 lbs. pressure per square inch.

Figs. 3 to 6 (Plates X. and XI.) form a picture-history of the alterations made during a series of trials, and as the story is from real life and is probably typical of many other cases, it will be interesting and instructive to briefly review the causes and effects of the various modifications.

As originally constructed it was found utterly impossible to make the piston workable and at the same time steam-tight. However carefully it was fitted when cold, the inevitable distortion of the valve-box under steam disturbed the relative concentricity and squareness of cylinder axis to valve face. By the time the piston was made a working fit it leaked so badly that its balancing effect was lost. The application of pressure gauges showed that with 250 lbs. per square inch on boiler side of stop valve and 20 lbs. in H.P. casing, the pressure in the balance chamber was only 25 to 30 lbs., leaving the opening gear to deal with an unbalanced pressure of 225 lbs. on the back of a valve even larger than the main steam pipe. It was useless to depend

on steam pressure accumulating between valve and balance piston with moving engines.

First, the holes through the core of valve were increased as much as possible; but this was found quite inadequate. Then new balance-chamber covers were made and fitted, having a separate steam supply pipe as in Fig. 3 (Plate X.). The balance piston, being made a very easy fit, was found to pass sufficient steam, with the main valve closed, to work the engines up to about half-speed, so a separate valve was fitted to the balance-cylinder supply pipe to be used as an auxiliary-regulating or manœuvring valve. The small holes through the core of the main valve being plugged up, it was then possible to effectively shut off the steam from the engines in a roundabout way; but this was considered unsatisfactory and we were requested to convert the valve into the double-beat equilibrium type, a reference plan (Fig. 4, Plate X.) being sent for guidance in the matter. It will be noticed that a distance-piece of the same material as the valve-box is inserted between the valves to compensate for expansion.

We proposed Fig. 5 (Plate X.) of which more anon; but this being too startling an innovation at that time valves as per Fig. 6 (Plate XI.) were finally fitted, having very large ports cast through the core to make up for leakage through the top valve. And so fitted, the vessel went into commission, the valves certainly being less liable to jam than the original balanced (?) type; but with all the defects of a common double-beat valve.

The annoyance of leaky regulating valves is a very real one to an engine-room staff. It is not always permissible to close the boiler stop-valves or even the shut-off valves usually fitted in the main steam pipe at the engine-room bulkhead, as under certain circumstances the engines may be stopped for hours in "stand-by" condition, ready at a moment's notice to move "ahead" or "astern." Consequently the steam is often allowed to leak through the engines; and the cylinder drains must be kept open continuously, adding greatly to the discomfort of the engine-room and increasing the danger of pressure accumulating in the receivers, thus blocking the engines when a sudden call is made.

A full appreciation of the foregoing conditions caused Mr. Bevis and myself to reconsider the design of main-regulating valves generally.

It will be remembered that on the introduction of high-pressure boilers the British Admiralty conditions for testing all valves and their gearing under water and steam pressure were enforced with unprecedented stringency, as witness the following extracts from machinery specifications:—

"All steam stop-valve boxes are to be tested to the full specified water pressure (double the steam pressure) with the valves open and also with the valves closed, when they must be tight on their seats. A subsequent test of these valve-boxes is to be made under steam of the specified working pressure with the valves closed and the pressure on the working side of the valves. These tests are to be carried out in the shops before the valves are fitted on board the vessel, to show that the valves are steam-tight. The efficiency of the opening and closing gear is to be tried during these tests. The handwheels of screw-down valves are to be large enough to close the valves against the full specified test pressure without the use of additional purchase."

We felt that it was no use going on increasing the thickness of metal, or designing weird castings to equalise the effect of expansion and keep the valve faces in shape. What we aimed at was something that would circumvent nature's forces, and if possible turn them to good account, as in the case of the hydraulic cup-leather, in which, as is well known, the greater the pressure the tighter the joint.

The double-beat main-regulating valve of the starboard set of engines in a twin-screw destroyer of 6,000 I.H.P. and 240 lbs. steam pressure per square inch was therefore taken out and altered as shown in Fig. 8 (Plate XI.).

The port-valve (Fig. 7, Plate XI.) was left as it was for comparison under identical conditions.

On testing the altered valve in the shops it was found to answer the most sanguine expectations. After a satisfactory preliminary hydraulic test to 500 lbs. per square inch, the inlet was connected to a boiler and tested up to 250 lbs. per square inch steam pressure.

During the test the outlet branch was left open and there was no lagging on the valve-box—the worst conditions possible for expansion strains. The space between the valves was closely examined with a light, a somewhat dangerous proceeding never or very rarely attempted in testing solid valves. No steam escaped and we subsequently opened and closed the valve several times with its own handwheel "without the use of additional purchase."

The solid valve of the port engines was also similarly tested alongside; but required the employment of a wheel-spanner and considerable force to close it.

Probably this had the effect of jamming the faces together even though slightly distorted, as the valve and box were entirely of gunmetal and, being for destroyer work, were as light as we dare make them; but in a very few minutes the effect of unequal expansion was evident, and shortly the valve was blowing, apparently full-bore. Anyway, there was no approaching its outlet for examination.

The action of the new valve is probably sufficiently clear from the sketch, but we may briefly describe it.

The larger valve consists of a flexible disc of hard-rolled bronze, the smaller valve being solid and of the usual type. The distance between the valve seats is slightly greater than that between the valves. Consequently, in closing, the flexible valve engages its seat first. The solid valve is then pressed home on its seat by the unbalanced steam-pressure acting on the central area of the larger valve, assisted by the handling gear. Any distortion between the valves and seats is thus taken up by the flexible disc which readily accommodates itself to its seat, leaving the smaller solid valve free to bed itself in its own seat.

The handling gear has only the difference to overcome. This difference it is rather difficult to estimate, as the effective area of the larger valve varies with the thickness of the disc. For the outer edge of the disc being supported all round by its seat it is clear that the thinner the disc the greater is its effective area for the purpose of closing the smaller valve. The handling gear, however, is there to overcome any slight difference, and the combination thus comprises an almost ideal equilibrium valve.

The solid (port) regulating-valve was refitted and made as good as possible before being put back in the ship, after which the vessel went through all her trials and we had good opportunities of comparing their behaviour.

On one occasion the destroyer had to put into Ramsey Bay, and the weather being very rough, steam was kept on the engines all night. No steam passed the flexible valve on the starboard engines, but the drains of the port engines had to be kept open all the time to prevent accumulation of pressure in the cylinders.

Some trouble was subsequently experienced due to the curled

edge of the flexible disc cracking, and various other forms and materials were tried (Fig. 8A, Plate XI.), culminating in the final adoption of a perfectly flat disc (Fig. 8E, Plate XI.). It is noteworthy that this was the first type thought of, but abandoned because it was considered necessary for the disc to have a stiff edge to maintain its plane. Here we were evolving a flexible valve and yet harping on the necessity of retaining a stiff edge or lip to the disc. It also proves once more that after all the simplest is the best. We went to considerable trouble in bending the disc to the required forms only to find that the metal had become distressed in the operation, and predisposed to rupture when exposed to high temperatures and pressures. Moreover it reduced the effective diameter for flexibility.

The present form, therefore, is a plain, flat disc of hard-rolled sheet manganese bronze, bearing on a raised lip forming the valve seat (see Figs. 9 and 9A, Plate XII.).

Should the disc take a permanent set it can be turned over and used again.

To facilitate overhauling the disc it will be observed that the top valve is made the flexible one, and a cover is provided to save disconnecting the handling gear.

The flexible type of double-beat valve has also been adopted with advantage for starting-valves to intermediate and low-pressure cylinders (Fig. 10, Plate XII.). They are so proportioned that the steam pressure always closes the valves when the starting levers are released, and they are of course always steam tight, whilst the small piston valves usually fitted for this purpose invariably leak, making it advisable to shut the master-valve after getting under way.

Apparently the disc retains its flexibility longer when the skin left on by the rolling process remains unbroken. But the amount of spring allowed is reduced to a minimum to relieve the disc of buckling action as much as possible. We find that $\frac{1}{64}$ inch of spring is ample in most cases, but this allowance may have to be slightly increased should the valve expand so much more than the valve-box that the difference allowed is overtaken.

However, a buckling effect of even $\frac{1}{32}$ inch in a 12 inch disc is scarcely perceptible, and as the number of changes from flat to buckled is comparatively few and not constantly intermittent, the disc lasts indefinitely.

A thin liner under the disc forms a ready means of adjusting the difference required between valves and faces, and also permits of re-adjustment whenever it becomes necessary to regrind the solid valve. It is the cutting action of the steam rushing through between the closed faces that ruins most valves and renders constant regrinding necessary. Never allow a small leak and you need never worry about a big one. A "whisper" of steam soon becomes a "roar." Moral: Keep a valve tight and the amount of regrinding required is *nil*. The following extract of a report received after the Autumn Naval Manœuvres of 1900, is *à propos* in this connection:—

"Great satisfaction is felt with the way H.M.S. "Thrasher's" main-regulating valves behaved during the manœuvres. The flexible discs are still absolutely tight, while all the other ships in the flotilla have had to have theirs ground in again."

Plain Stop-valves.

The success attending the adoption of the flexible disc in double-beat valves suggested that something of the same nature might with advantage be applied to ordinary large stop-valves, *i.e.*, screw-down valves with single seats, and in which the steam passes through a single opening.

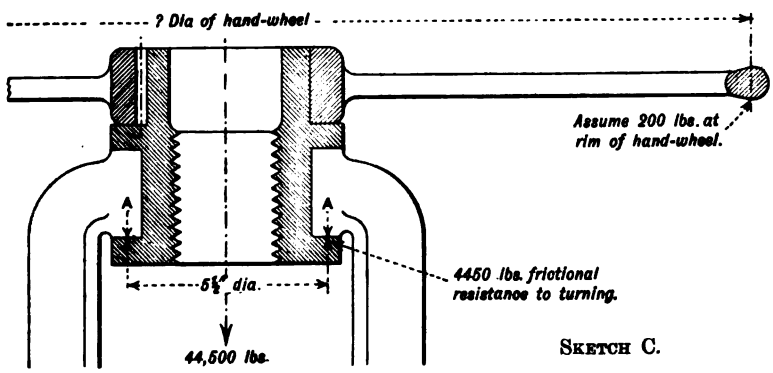
A few preliminary observations as to the working stresses in plain stop-valves may not be out of place, and we might appropriately take the Admiralty requirements hereinbefore recited as our text.

In closing an ordinary stop-valve against pressure no stress comes on the closing gear until the final pinch. The load comes on not, as is commonly supposed, just before closing, but just after, when it is desired to shut the valve tight. To tighten up the valve you must go on turning the handwheel after the valve has touched its seat; thus compressing the spindle, springing the cover, and stretching the walls of the valve-box until sufficient energy is stored up to overcome the load under the valve represented by its area × steam-pressure: which load in a 12 inch valve for 300 lbs. pressure per square inch amounts to over 15 tons. The apparatus is now in the position of a huge safety valve on the point of blowing off. There is no margin available to press the faces together and make what is known as a joint. The most effective way to make the joint is to proceed in a manner analogous

to tightening up a pipe joint and heave up on the cover studs if we can; but this is not permissible. We must, therefore, still go on turning the handwheel and storing up more potential energy in the spindle, etc. And this must be done, to quote our text, "without the use of additional purchase" by means of the handwheel and screwed spindle. If any difficulty is experienced the remedy that naturally presents itself is to fit larger handwheels and reduce the pitch of thread on the spindle.

The first surprise we encounter is that no advantage is to be gained by adopting a finer pitch of thread, or even by fitting differential screw gear in very large valves; and as for fitting larger handwheels, few engine rooms could afford the space necessary to accommodate the enormous handwheels that would be required.

Let us take a typical case. Sketch C shows the closing gear of a 13 inch stop-valve in a vessel carrying 300 lbs. boiler pressure. Assuming a co-efficient of friction = $\frac{1}{10}$ and that a man can exert a force of 200 pounds on the rim of the handwheel, what diameter of handwheel is necessary to just close the valve against the pressure?



SKETCH C.

The load on the Spindle = 300 lbs. × area of $13\frac{3}{4}$ inches valve = 44,500 lbs.

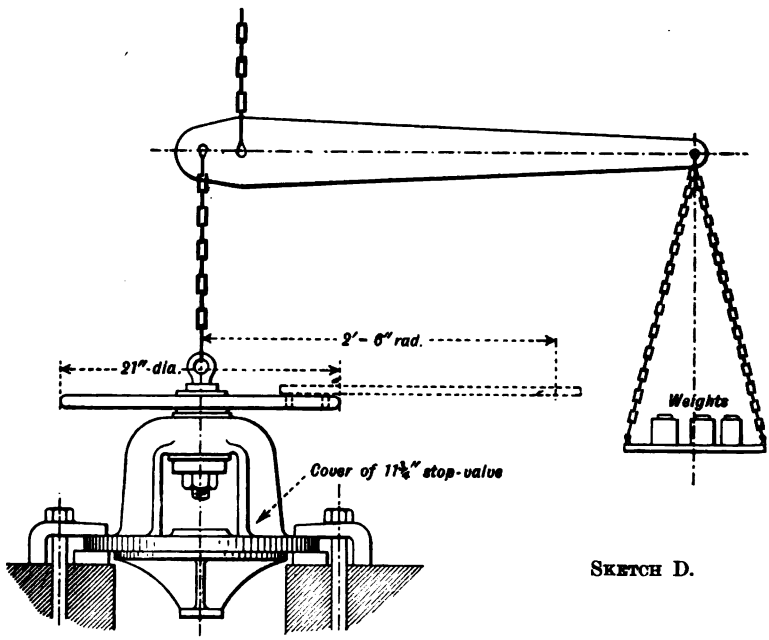
Then Friction = $\frac{44,500}{10}$ = 4,450 lbs. acting at A, $5\frac{1}{2}$ inches diameter.

Therefore the diameter of handwheel to overcome friction alone = $\frac{4,450 \text{ lbs.} \times 5{\cdot}5 \text{ inches}}{200 \text{ lbs.} \times 12 \text{ inches}}$ = 10 feet 3 inches diameter.

To tighten up the valve either the diameter of handwheel or the power at the rim would have to be still further increased.

It will be observed that "pitch of thread" does not enter into the above calculation, and to prove that "pitch" is immaterial, attention is directed to the following results of an actual experiment.

Referring to Sketch D it will be seen that the cover and gear of a large valve were secured to a base-plate, and by means of a steelyard the spindle was loaded to represent equivalent loads due to steam-pressure acting under a frictionless piston sliding in a perfect cylinder of the same diameter as the valve.



SKETCH D.

It is remarkable that it was just as difficult to move the handwheel one way as the other. Therefore the prevalent idea of pressure helping to open a valve is quite erroneous. But, you might object, it is surely easier to push a load down-hill than up-hill? Well, it all depends on the nature of the road and its steepness. If the declivity is very slight and the load is skidded—not rolled—it makes practically no difference. And a loaded nut turning on a screw, metal to metal, is an exactly parallel case.

The pressure between the threads is so severe that ordinary means of lubrication are of little avail. Probably some relief might result from the employment of ball bearings, and possibly they have been tried; but the load would be too great for the balls and their races to stand long.

Load on Spindle.	Equivalent Steam Pressure on Valve.	Results.
lbs.	lbs. per sq. inch.	
2,141	17·4	Wheel could be turned by 1 man with difficulty.
3,373	27·4	Wheel could just be turned by 1 man with great difficulty.
4,605	37·4	Wheel could just be turned by 2 men with great difficulty, or 1 man using a bar at 2 feet 6 inches radius could just manage to turn the wheel.
5,837	47·4	2 men at radius of 2 feet 6 inches with difficulty.
7,069	57·4	2 men do. do. with great difficulty.
8,301	67·4	2 men do. do. could just manage to turn wheel about 1 inch at a time in jerks.

In addition to the load on spindle necessary to overcome the pressure of steam, comes again the problem of distortion due to unequal expansion, although this defect is not so accentuated as in the case of double-beat valves. When the valve and seat are brought into contact there may be, and there generally is, under the action of steam, one side of the valve which persistently blows, showing that the faces are not now strictly concentric and parallel. This effect is doubtless aggravated by the lack of symmetry in the supporting walls of the valve-box. In a common globe stop-valve for instance (Fig. 11, Plate XIII.) one half of the seat is supported from below, the other half being hung from the portion next the cover. In a right-angled stop-valve (Fig. 12, Plate XIII.) the seat next the outlet branch loses the support of the cylindrical walls of the valve-box.

Webs, or ribs, are sometimes cast as shown in dotted lines, to afford additional support, but these do not entirely overcome the defect.

The want of concentricity is got over in a measure by abandoning the conical seat in favour of flat faces. Various expedients are adopted to so secure the flat seats that while they are free to expand and contract circumferentially they will bear only on the flat ring of the valve-box metal, and offer a true, flat surface to engage the valve. Some of these methods are illustrated in Figs.

13, 14 and 15 (Plate XIII.). But the retention of the planes of contact is not so easy, and if a surface plate could be applied we would see that, due to the effect of temperature, the surfaces had gone woefully out of truth. Powerful closing gear, assuming the parts are not too rigid, would no doubt force the faces into more intimate contact and minimise the leak; but this means again the employment of undue force, which is to be deprecated.

Moreover this force must be added to the power required to overcome the normal load before the total stress in the spindle necessary to make the valve steam-tight can be arrived at.

Again, to show that the expansion of the spindle is a factor that cannot be ignored we might direct your attention once more to the method of steam-testing such valves separately in the shops. I do not suppose I am giving away any trade secrets when I tell you that advantage might be taken of the expansion of the spindle to make a refractory valve pass a satisfactory test. After the valve is closed down it is only necessary to keep the valve-box cool, and allow the heat to gradually climb the spindle by conduction. The spindle, of course, lengthens imperceptibly and thus provides the final pinch, when the full test pressure may be safely applied.

But try now to open the valve and you will experience a striking example of the irresistible power of expansion. The elongation of the spindle has so jammed the valve into its seat and put such an enormous pressure on the threads that it is often impossible to shift the handwheel and recourse must be had to slacking the cover or bridge bolts before the screw-spindle can be released and turned.

As honourable members of an honourable profession, however, we are concerned, not in dodging the inspector, but in circumventing nature—if we can. We want to make a valve honestly tight under working conditions. One method of eliminating the effect of the expansion of the spindle is shown in the "spring bridge" type illustrated in Fig. 15 (Plate XIII.) As the spindle elongates the four springs are compressed slightly. Thus the stress in the spindle never exceeds a certain pre-determined amount. The combination is practically a large screw-down safety valve designed to blow-off at about 50 per cent. above the working pressure.

The makers of this spring-bridge stop-valve have lately introduced a fixed system of wheels and levers in place of the ordinary handwheel for shutting the valve tight and starting it open. This is shown in the sketch. A report just to hand states that these valves "could be manipulated by hand with the wheels and levers provided and closed against the full steam pressure of 325 to 330 lbs. per square inch, without the use of any additional purchase." The minimum force required to open and shut the valves steam tight was measured and found to be as follows:—

	Pull on ever at 1 foot radius. To shut. lbs.	To open. lbs.
6 inches diameter of valve	140	300
4 ,, ,, ...	69	150

Three hundred pounds is a tidy pull to close a comparatively small valve, and with the aid of gearing. The equivalent simple handwheel would be about 8 feet diameter for the 6 inch valve!

Here again, therefore, the principle of the hydraulic cup-leather occurred to us. Why not construct a valve in which the steam pressure itself makes the joint? Hence the flexible-seated stop-valve; the converse of the flexible valve as applied to the double-beat arrangement. Referring to Fig. 16 (Plate XIV.), it will be seen that the flexible seat consists of a thin annular disc of hard-rolled bronze the inside edge of which forms the actual seat. A junk ring secures the flexible seat, and provides an abutment underneath to prevent undue distortion of the seat: it also becomes a back-pressure seat in the case of self-closing, or screw-down-non-return valves.

The action is as follows:—The valve being run down by the closing gear very little power suffices until the valve actually touches its seat. But the seat does not wait to be touched. When the opening is reduced to about $\frac{1}{64}$ inch the pressure and rush of steam bend the seat slightly towards the valve and immediately make a perfectly steam-tight joint. If we can get another half turn on the hand wheel so much the better; but the fact remains that with little exertion and no undue force the largest valve can be shut tight against the heaviest pressures. It is actually more difficult to open this type of valve than to close it: but never so difficult as with the solid valve, for it is impossible for it to jam by expansion of the spindle.

By means of a wheel-spanner; or, better still, by the podger-pinion and spur wheel gearing shown in Fig. 15 (Plate XIII.) the valve is started open. Naturally the seat acts like a sucker and moves up with the valve until its increasing spring assisted by the abutment afforded by the junk ring detaches it (probably at one portion of its circumference first) when the rest is easy.

The exact thickness of the flexible seat depends on the amount of unsupported lip that can be allowed, and this again is limited by the size of hole for the cover. Generally, however, experience proves that the thinner the seat the better; anything between 16 and 22 L.S.W.G. being ample in most cases.

The first discs tried were much too thick and proved extremely rigid when gripped all round at the outer edge by the securing ring.

Figs. 17, 17A, etc. (Plate XIV.), show the effects of the varying thicknesses and forms of seats tried in the first experimental stop-valve, which was an 11¼ inch screw-down-non-return valve for 300 lbs. steam pressure, the body being of cast-steel. The hole for cover was just large enough to get the ordinary seat in so there was not much to come and go upon. Some of the seats experimented on are among the specimens here present.

As in the case of double-beat-valves various types of lip were tried with varying success and finally we came back once more to the simplest and best: viz., a perfectly flat annular disc cut out of hard-rolled sheet bronze and trued up, care being taken to remove any feather edges (see Figs. 16A and 17E, Plate XIV.).

This gives the maximum length of cantilever for spring, and the material is not distressed in the manufacture. Moreover the seat can be taken out and reversed if required.

Very often these non-return valves are placed with their spindles horizontal, in which case it is advisable to drain any water away from the disc as shown in Fig. 16A (Plate XIV.). Having condensed water at one part of a valve seat and live steam all round elsewhere is not conducive to tightness in a flexible seat any more than with the ordinary solid seats.

Figs. 18 and 19 (Plate XIV.) show methods of applying flexible seats to existing valve-boxes.

Four large valves in the main steam pipes of a battleship recently completed were fitted with flexible seats: the main regulating valves also being of the flexible double-beat type.

I thought it would be interesting to show some of these actual discs at this meeting, so during the opening-out after trials I applied for any discs that it might be necessary to renew for exhibition here.

The reply I received forms an unconscious testimonial to the efficiency of the new type of valves. It reads as follows:—

"With regard to the flexible valves and seats, they were entirely satisfactory on the trials and quite steam tight, and in those since opened out, the movable parts were found in very good condition and not at all damaged by steam passing through. None of the parts needed replacing and they were closed up as before, nothing being done to them except cleaned. We have still a Bkhd. S.V. in Port Engine Room to open out and examine, but I don't anticipate any defects.

"If they should require any new discs I will forward the old ones to you as requested."

It will have been noticed that the types of flexible valves hitherto described are one-way valves, *i.e.*, the flow of steam is supposed to be in one direction only. Should it be required to fit up a double-acting flexible stop-valve, a combination such as illustrated in Fig. 20 (Plate XIV.), would no doubt meet the case.

Before concluding this paper I would suggest that another way of reducing the liability of stop-valves leaking in extensive steam pipe ranges, is to curtail the sizes of the stop-valves themselves in relation to the pipes.

Why, for instance, should a range of 12 inch steam-pipes have 12 inch stop-valves with a clear area equal to a 12 inch pipe throughout, and with all the massive fittings which a 12 inch valve entails, when a smaller valve would answer the purpose just as well?

One of the first jobs an apprentice draughtsman gets is a stop-valve, and one of the first principles of design impressed upon him is to allow plenty of area through the most restricted parts of the valve-box.

With what secret pride does he enter into his note book that for equal areas the lift must equal a quarter the diameter of the valve: or $l = \frac{1}{4} d$, with its accompanying proud sketch.

Now in actual service these valves are seldom wide open. The boiler stop-valves are opened say $3\frac{1}{2}$ turns instead of 9 which would be "full open:" the intermediate shut-off valves are half opened; and the engines are going full speed with the main regulating valves one-third open, no increase of speed

resulting from a greater opening. Separators in the main steam pipe have orifices about one-quarter the area of the pipe—and so on.

If then the system works all right with its stop valves half open why not take the bull by the horns and make all the stop-valves half the area of the pipes, so that our 12 inch range of pipes would have, say, 8½ inch stop-valves throughout?

It is well-known that a short obstruction in a line of piping, especially for steam, has very little effect in choking the flow. Why not deliberately apply this knowledge to stop-valves? In many ships the saving would be considerable, and in any case some reduction on the lines proposed should be well worth consideration.

DISCUSSION.

The SECRETARY read the following communications:—

LIVERPOOL, 15*th Dec.*, 1902.

DEAR MR. DUCKITT,

I have perused with much interest the paper read by Mr. J. Hamilton Gibson at Sunderland upon large stop valves for high pressure steam, and can readily endorse all the difficulties as set forth by the writer, and the thoughtful means adopted to make a really tight valve—a thing one so seldom finds, more particularly in auxiliary engines and smaller sizes of valves, which are a source of great loss of fresh water, and the cause of endless split pipes and cylinders in severely cold weather. I should like to mention one or two experiences. Some years ago, upon an important Atlantic liner, on arrival the stop valves were all closed down. Later on steam was raised for the return voyage, and the order given, "Open stop valves," much easier said than complied with. It was found that two of the main stops could not be opened. The bridge being of the solid type, it will readily be seen how this happened. As stated in the paper, it was due to more rapid expansion of the brass spindle than the surrounding metal, thereby placing an undue pressure upon the valves, the spindles eventually being found bent within the valve chest when opened out.

Later on came an elaborate double bent equilibrium valve, which never was tight; the easing gear being very powerful,

the one valve was cut off and made single, which proved a decided advantage, and was worked for years afterwards as such.

Then came a stop valve upon the engines of the flat slide valve type, having a loose plate face, with a raised flange at each end, and a block attached to the valve spindle $\frac{7}{8}$ inch less in length than the distance between the end of the flanges. It was found that when working the reversing gear that the engines were somewhat too lively; if the link passed the centre, off they would rush in that direction, and the link had to be placed carefully in mid gear when standing.

Upon opening the valve it was decided to fill in the clearance at the ends of the loose face, leaving only $\frac{1}{32}$ inch freedom. Well, one can certainly learn by experience, and our dismay was complete when it was found that two men could not move the throttle, which was worked by a quadrant lever and bell crank. The valve was again opened and $\frac{1}{8}$ inch clearance given, when by the slight blow afforded by this backlash it worked admirably and the annoyance ceased.

As regards the stress Mr. Gibson lays upon the custom of applying levers and extra power to force a valve to become steam tight, I consider this simply barbarous treatment, if not dangerous. I maintain, if a valve fits its seat accurately and is kept in good order, all the squeezing you may apply will not mend matters.

I am not sure if these few actual experiences will be of interest, and in conclusion I beg to thank Mr. Gibson for his interesting paper, and hope the device of the flexible or other disc will be more generally applied to the minor stop valves (having a suitable check in case of the thin disc being sheared), which are such a source of waste, as for instance the amount of leakage from steam winches, etc., when steam is supposed to be shut off, and the consequent annoyance of water running over the decks, and hot water dropping from various places when below, all due to defective stop valves.

Yours faithfully,

JOHN J. ATKINSON.

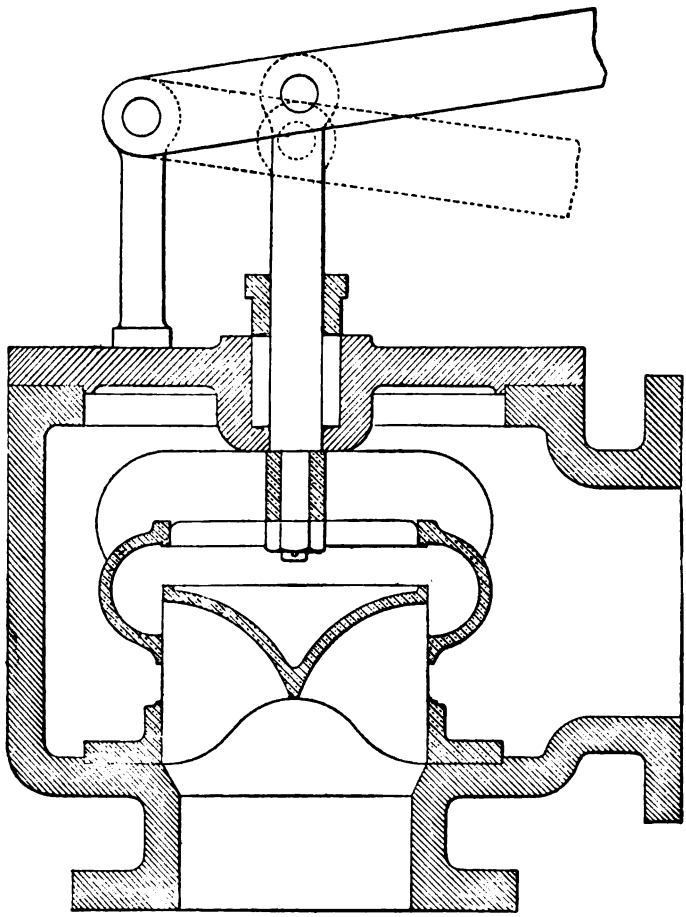
BLOOMFIELD, BELFAST, 10*th Dec.*, 1902.

DEAR MR. DUCKITT,

Seeing that the author of a paper to be read this week is of opinion that double-beat valves cannot be made steam tight, I

venture to send you the drawing of an old type of valve which I have fitted to a number of engines, and in every instance it has proved absolutely steam tight under pressures up to 180 pounds. (See Sketch E.)

Yours faithfully,
H. MacColl.



Sketch E.

The discussion was adjourned, and the meeting dissolved.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.

NINETEENTH SESSION, 1902-1903.

PROCEEDINGS.

THE ANNUAL DINNER.

The Annual Institution Dinner was held in the Assembly Rooms, Westgate Road, Newcastle-upon-Tyne, on the evening of Friday, January 16th, 1903, the President, John Tweedy, Esq., J.P., in the chair. The President was supported by the following:—Past-Presidents—Col. H. F. Swan, C.B., and Mr. Henry Withy. Vice-Presidents—Mr. W. C. Borrowman, Mr. Arthur Coote, Mr. J. R. Fothergill (Chairman of the Dinner Committee), Mr. Henry Fownes, Mr. Summers Hunter, Mr. H. B. Rowell, and the following guests—The Lord Bishop of Newcastle (Dr. Jacob), Alderman T. Richardson (Deputy Mayor of Newcastle-upon-Tyne), Councillor J. M. Oubridge (Sheriff of Newcastle-upon-Tyne), Mr. P. Hodges (Messrs. Cammell & Co., Sheffield), the Rev. Dr. Gurney (Principal of the Durham College of Science, Newcastle-upon-Tyne), Mr. M. Walton Brown (Secretary, North of England Institute of Mining and Mechanical Engineers), Mr. John Gravell (Bureau Veritas Register of Shipping), Mr. T. Kenyon (President of the Newcastle-upon-Tyne Association of Foremen Engineers), The Hon. Treasurer—Mr. G. E. Macarthy. Members of Council—Mr. James M. Allan, Mr. M. C. James, Mr. D. R. Macdonald, Mr. James L. Twaddell, Mr. John Duckitt (Secretary), and others to the number of about 150.

An excellent repast, served by Messrs. Tilley & Co., Limited, was partaken of. Mr. Robert Smith's Royal Orchestra played a selection of music during the evening.

After dinner a short toast list was submitted.

The PRESIDENT (John Tweedy, Esq.), at the conclusion of the dinner, proposed the toast of "The King." He said—I do not suppose any nation has ever been more happy at any time in history in its monarchs than we have been during the late and present reigns, nor have any people been more whole-hearted in their loyalty than we, and I have much pleasure in proposing "The King."

The toast was drunk with musical honours.

The PRESIDENT—I have pleasure now in asking you to drink to "Queen Alexandra, the Prince and Princess of Wales, and the rest of the Royal Family."

The toast was drunk with musical honours.

The LORD BISHOP OF NEWCASTLE proposed "The North-East Coast Institution of Engineers and Shipbuilders." He said—My friend the Sheriff of Newcastle-upon-Tyne said to me just now that he and some others were dying to hear what a bishop had to say in proposing a commercial toast. Well, you have called upon a very uncommercial man to propose a commercial toast, and I am afraid I must say a very unscientific man to propose a scientific toast, but for all that really it is a pleasure sometimes to get out of a groove, and as I am a citizen, and not merely a bishop, I respond to the request which has been made of me, and I take upon me the burden of proposing this toast to-night. Now let me say, in proposing to you the toast of the North-East Coast Institution of Engineers and Shipbuilders, I am proposing, I know perfectly well, a toast which refers to a body that is exceedingly influential as a body of experts, not merely in reference to the North-East Coast alone, but in reference to, I may say, the affairs of shipbuilding and engineers in England and the British Empire at large. Indeed, when I know that delegates go from this body to Lloyds and to other bodies, and when I have seen, as I have seen very recently, an exceedingly—I won't say revolutionary—but to me who have lived at Portsmouth for nearly eighteen years, almost a revolutionary scheme with reference

to officers of the British Navy, I have a shrewd suspicion that this body of yours has been consulted, and has had some sort of hand in that very remarkable memorandum which bears the name of the First Lord of the Admiralty. And therefore I am proposing to you a toast of a body which has extreme influence even in the affairs of the nation at large. But, let me say, there is another point on which this North-East Coast Institution appeals to me very greatly. It is an Institution which seems to me to develop the capacity of the individual belonging to it as far as it is possible for that capacity to be developed. Perhaps I may be allowed just a little bit to explain. When I was an undergraduate at Oxford, there was a school of thought which was represented largely by a great philosopher, John Stuart Mill, which was a school of thought that I should describe as individualistic. That is to say, the individual was everything, and the body was comparatively of little importance. That was pushed to an extreme degree in matters of political economy, and I felt myself, even in those days, that a pitiless individualism was scientifically and morally something which would lead to a reaction. Well, the inevitable reaction came, and it took the form of what I may perhaps call collectivism, or socialism. I do not use the word socialism invidiously at all. What I mean to say is, that whereas the former school was characterised mainly by attention to the individual, that school which, by the inevitable swing of the pendulum, followed it was one which almost lost sight of the individual in what was thought to be the general good of the community. Now if there was, as there was, a pitiless individualism, I am enough of an outsider to be able to say that there is a very real danger of a pitiless individualism being followed by a no less pitiless socialism. And what the evil of this collectivism of the day—for it has its good points, and its very good points—is, that there is a tendency in certain quarters to sink everybody almost to the same level; to prevent a man's capacity coming out; to prevent a man rising, lest he should in any sort of way get beyond his fellows, and if this were to prevail the result would be the retarding of the development of the individual man, and the retarding of the progress of the nation, for that nation is bound to prosper most which brings out the latent capacity of all its citizens, and which develops

that capacity to the very utmost possible power. Now, this North-East Coast Institution of yours is an Institution which seems to me to put the capacity and the experience of the best men amongst you at the disposal of the youngest. It is an institution in which a young man is able to learn what other people have been able to arrive at, and he is able, by the society in which he mixes, by the papers and the books which are accessible to him, and by converse with men, many of them much older and more experienced than himself, he is able, as it were, to put brain against brain, and he is able to develop. It seems to me that when you compare the education of England with the education of some other countries that I might mention, unless we really do in England improve our education of every kind, unless we bring out what there is in men to bring out, we are likely in important matters to fall very much behind. I have paid in the course of the last twenty years three visits to the United States. I spent two months in North America in 1901. I have visited a considerable number of factories in the United States, and I have taken some interest in American education. May I just tell you one or two things which have struck me? If you go to New York you will find public schools, beginning with a kindergarten which any child can attend from the ages of 4 to 6. From 6 you would find all these children drafted—and very many who have not come before, because education is not compulsory till the age of 6—drafted into primary schools. At the age of 9 they would be drafted into grammar schools. They are obliged to stop at these schools until they are 14. Of the half million or so of children who are in the public schools of New York, you will find about 9,000 every year pass from these grammar schools into the high schools at the age of 14. Of these 9,000 about one-third fall away in the course of one year, but the other two-thirds go on, and of that number about 1,400 graduate at the age of 17½ or 18. All the education from the beginning to the end is free. Then at the age of 18, if they desire, they push on further still. There is a normal college for young women and the City of New York college for young men where they are still able to go. Out of about 1,400 who graduate at the high schools there are about 1,300 who pass on to these practically university colleges, where they can

take a degree. A great number of the leaders of industry and of the leaders in trade of New York have in this way come up from the lower ranks of life to the higher. Their capacity has been developed, they have been trained, and a leading man of New York told me he never understood the real reason for the immense advance of New York commerce until at the request of that most admirable mayor of New York, Mr. Seth Low, he took a seat on the Board of School Commissioners, "and then," he said, "there in the public school system of New York I saw the real reason for the advance of New York commerce." Let me say a little more, if I may, about this education. I go into factories in America, and I find some men there who are entirely occupied in giving their brains to invention. I go, for instance, into a factory at Waterbury, where watches are made, and I observe there two or three men who give their entire time to improving the inventions, and improving the means of machinery. Well, the manager told me that his men there had learned that improvements in machinery were really to the interest, and not to the hindrance, of the men. He shewed me one of their newest inventions and he shewed me some fifteen men employed in making it in the old fashion, and said, "I have an automatic machine invented by one of our own men. It is in the cellar, because I have not been able to use it in public yet, but soon these fifteen men will all be displaced by that automatic machine. But they will not be displaced altogether, because as our machinery is improved our trade is improved, and these men will simply be put to other work, and not displaced from their work altogether, and they know it perfectly well." I had seen many different factories in England, but I could not help feeling when I went over this American factory that there was an illustration of employers who knew how to bring out all the capacity of their men—of employers who were determined to develop the individual so far as they could, and who made it worth their while for two or three men to be nothing but inventors in order that their machinery might be improved. I could not help feeling that some of our men in England should go and see, as some have done, these things for themselves. They might learn a wrinkle which might be of service to them in their combinations and in their work at home. When you go into other countries

like Germany and the United States, and you see the way in which individual capacity is being trained and developed, then I venture to say you cannot help coming to the conclusion that this old country of ours must, as the Prince of Wales very well put it, "Wake up," if it is not to lose a good deal of the trade which has hitherto been put into its hand, and it is because I believe this North-East Coast Institution of yours really does tend to develop the individual and to bring out what is in the capacity of a man that it appeals to me very strongly indeed. But let me go further, if I may, and say this. If this Institution were just to develop the individual capacity and there to end, I should say there was something wanting in it; but it is just here that what I may call the moral side comes in, because I maintain what a nation wants is that the individual capacity should be developed as far as possible, but that a man should be taught, and taught from early childhood, that his capacity, and his genius, and his fortune, whatever they may be, are not merely for himself alone, and that in developing that capacity and improving that fortune as he may, he is bound to consider the public good. Train men like this, and teach them that, having made their fortunes, they are not to forget men who have not been equally fortunate. They are to remember them, and try and develop them too. That is the way, I venture to say, in which the collectivism takes good and proper and moral shape, and that is the shape I should like to see it assume more and more in this motherland of ours. Again and again, I must venture to say, we get a lesson from across the water there. You cannot find anything more instructive in America than what was done by the grand old Quaker, Johns Hopkins, at Baltimore, when he entrusted some distinguished citizens of Baltimore with the task of founding an hospital, and others with founding a university, which was mainly to have shape given to it by the men he trusted, not merely for training undergraduates, but chiefly a university for training graduates, giving them a thorough scientific knowledge. When the University of Chicago was started it contained, I believe, no fewer than forty professors and lecturers who had earned their degree in Baltimore. This is an illustration of the way in which a man of wealth can use his money for the public good. I cannot help saying that I sincerely hope that while we have a development of education in our own country

our men of wealth will never forget that no State by itself can do all that is really needed for the education of the people. There will always be ample scope for the individual benefactor. I should like to see the College of Science, represented here to-night by my friend the Principal, endowed more largely. I hope there will be scholarships offered, not only from public but from private funds, for the training of young men in our grammar and other schools, and of giving them the chance of rising, if they have the capacity and the character to do so. Therefore I say, while I am speaking of the necessity of State action, and the necessity of collective action, I do ask that there shall be as great as possible encouragement of the rich benefactor, and I trust that there will be a great deal still offered to our colleges and to our universities by way of encouraging the education of our young men and our young women as well. One more point, and I have done. This North-East Coast Institution of Engineers and Shipbuilders is not an Institution for all England. It is one which develops a good deal of local patriotism. We on the North-East Coast are a people by ourselves, and we have our common associations. We inhabit a country which is, I venture to say, as beautiful a country as you can find almost anywhere in England—these northern counties of ours; but I am free to admit that what you may represent, and what is represented still more by the mining industry, does not altogether improve the beauty of the country; and if it is a combination of beauty and the beast, as somebody has called it, at any rate the beast produces the money, and is not to be despised. There is too, as you know, after all, a beauty in design, and a beauty in all those things which come from that commerce and come from that science which are represented and which are developed by the Institution to which you belong. I have undertaken this duty of proposing the toast of this Institution, speaking as an outsider, yet at the same time speaking as a man living amongst you, and trying, I hope, to identify himself with the widest interests and with all that can develop every part of a man here in this place in which I live. I give you the toast of this North-East Coast Institution, and I couple with it the name of your respected and admirable President, Mr. Tweedy.

The toast was cordially honoured.

The PRESIDENT, in response, said—I wish first to say how grateful we are to his lordship for his kindness in coming down on such a cold night to patronise our Institution, and for his most eloquent, interesting, and flattering reference to the work of our Institution. We are indebted to you all for the very hearty response you have given to the toast. The Institution is a prosperous and successful Institution, and I think it deserves to be a prosperous Institution. I do not suppose you will find a record anywhere more splendid than the record of the Tyne, Wear, Tees and the Hartlepools. During the last ten years the members of this Institution have built about 7,000,000 tons of shipping, and have spent £130,000,000 or so in wages and material. In return for this expenditure they received exactly the same amount, with perhaps a few odd pounds added, occasionally, as a kind of "backsheesh." So we have reason to be proud of the work done by its members and of their generosity. Visitors, I am afraid, knowing of this great work, will have concluded that we must be a proud people, but I assure them it is not so. We know we have covered the seas with splendid examples of naval architecture, in vessels of commerce, of war, and of pleasure, but on looking back we see the many blunders we have made. We are humble in respect of the past, and have visions of the more scientific and much better ships we could again cover the seas with if shipowners would only give us the opportunity of doing so. This humility as to the past is an interesting characteristic of shipbuilders and marine engineers. If any shipowner here to-night would only give the least hint, to-morrow he would receive such proposals and such beautiful designs as would prove to him that the best thing he could do would be at once to proceed to order more vessels. Before sitting down I wish to refer to a subject which his lordship has also referred to. As you know, Lord Selborne has inaugurated a new departure in the education and training of the officers of His Majesty's ships which is probably the most remarkable alteration in the organization of the service since the time when the sailor was substituted for the soldier. It is gratifying to find that the change is to some extent due to the action of this Institution. We have fought this question very hard and I am sorry to find one member in particular who has done so much splendid work in bringing

about the change is absent to-night. I cannot give you the name of the writer, because he is in the service, but the extract from a letter, which I have now in my hand, represents fairly the average views of men who have been in the service many years, and who therefore ought to know something of that about which they speak. The writer says—"Every naval officer will be instructed in the principles of mechanical science and engineering, and, whether he ultimately serves as an engineer officer, or whether he elects to enter any other branch of the naval service, the value of such a training"—(that is, several years of generous and liberal scientific education so organised as to keep the student in touch with the practical application of the science taught)—"to an officer serving on board a warship, or connected with the work of administering the Navy, must be of enormous advantage, and the nation is to be congratulated on Lord Selborne's splendid effort." There is one other aspect of the question I should like to draw your attention to. The memorandum of Lord Selborne will influence engineering science outside the Admiralty as much as in it. All branches of engineering will be affected by that memorandum. It will do much to improve our technical education methods. It will certainly do more than thousands of speeches or than any number of examples and illustrations drawn from Germany and America. The piece of paper occupying four or five sheets of foolscap issued recently by a gentleman occupying a high position in the Government will help Colleges of Science and improve the methods of our engine and shipbuilding works. Cambridge and Oxford will also be influenced by this memorandum. Amongst the men who enter our colleges and universities some may have peculiar talents and abilities for scientific occupations and these institutions will find it is their duty to seize hold of such men and fit them to become leaders in such pursuits. All who go to Cambridge and Oxford are not necessarily born lawyers, nor, if his lordship will permit me to say so, may they be fitted for the church. There must be some men amongst them who are specially endowed with qualities that will be useful in engineering. Our friends here who are occupied in building ships of war and machinery of war will presently have amongst them men of the new school, and I am sure that the works in this district, and in all districts, must in the future be manned and officered by men

possessing exactly the same attainments. Where they will get this education I do not know, but I think employers would do something to encourage men if they would open their works more generously to rich and poor alike, who happen to have acquired the necessary scientific training. We are likely to have for some time what is called a "slack time," and I would suggest to our young men especially, who may not be so fully occupied as we could wish, that they should take up some scientific subject, and work and grind at that subject with all the powers they possess, for it is certain that the next ten or fifteen years will see great changes and greater demands on the staffs of our works. I have to thank you all for the way in which you have honoured the toast, and the patient hearing you have given to my rather tedious remarks.

Mr. HENRY WITHY, Past-President, said—It affords me great pleasure to propose the health of "Our Guests." We all feel, I am sure, that our Institution dinner at any rate would be incomplete without the presence of friends. We are exceedingly pleased to see our friends here, and very proud to enjoy their good fellowship. I have before had occasion to observe the good fellowship that exists between the various competing firms in each district, and it is a very great pleasure to find that that good fellowship extends to other towns as well. We have had cordial invitations from other districts to visit works. During the past year we had an exceedingly pleasant visit to Sheffield, and we were most interested and instructed by seeing all over the works of Messrs. Cammell & Company. We enjoyed that visit very much and we look forward to other visits of the same nature in the future. We have also had the pleasure of a visit from the Institute of Mechanical Engineers to this district, and members of our Council formed the nucleus, I believe, of the committee of reception here. The members were shewn over many works in this district, and also in Sunderland and Hartlepool, and it afforded us great pleasure to be of some little assistance to them when they were here. If we had not invited any guests to-night we should not have heard the most instructive and learned address delivered by the Lord Bishop. The Lord Bishop referred to the small part that this Institution took in urging upon the Admiralty to

secure better conditions for the naval engineers, and I may say I am personally very proud that the small action we took in that matter appears to have had some effect. I must not weary you by giving you a list of our guests. I should take the rest of the evening if I were to tell you of all their virtues, but I have only to couple the toast with the name of Alderman Richardson, of Newcastle-upon-Tyne. Alderman Richardson is so well known in Newcastle-upon-Tyne that there is no need for me to sing his praises, but perhaps I may inform you that he has been appointed Chairman of the Committee appointed by the Corporation to report upon the constitution of the new local authority for education for this county borough. That is an exceedingly important office, and I am sure no gentleman could have been found with better abilities for the post than Alderman Richardson. He knows the work well, and has been Chairman of the Newcastle Grammar School for a long time. In his hands the report upon the constitution of the education authority will be most carefully and excellently prepared. I ask you to drink to the health of "Our Guests."

The toast was drunk with enthusiasm.

Alderman RICHARDSON, in reply, said—I owe my place here to-night to the fact that for the time being I am the official representative of the Mayor and Corporation of this city. I think it exceedingly thoughtful on your part, and at the same time quite reasonable, that you should associate the Mayor and Corporation of this city with festivities such as these, and that, not only because of our reputed gastronomic qualities, but mainly on account of the fact that there is no public body more deeply interested in your prosperity. Situated as Newcastle-upon-Tyne is in the centre of a great manufacturing and exporting district, we regard with pain any evidences of depression or decadence of trade, and we mark with joy every fresh symptom of expansion and progress. But for the immense coal-fields on every side of us, but for the manufactories, the shipbuilding yards, and the arsenals immediately contiguous to us, Newcastle-upon-Tyne could never have attained to its present population, wealth, and prosperity. The extension of the city is not due to any action of its Corporation, but rather

to the skill and enterprise of its merchants, its engineers, its manufacturers and its shipbuilders, and it ought to be the aim of the Corporation to conserve all these interests, not to crush them out of existence by excessive local taxation, or to harass them with needless bye-laws and obstructions, but on the contrary to advance their well-being by every legitimate means. And there is another reason perhaps why the Corporation should be identified with this festive gathering, because, representing the life of the city during the last hundred years, we have been identified with the greatest achievements of science. Newcastle-upon-Tyne is the birthplace of the locomotive, and associated with Newcastle-upon-Tyne are the names of the great men, the Stephensons and the Armstrongs, who, by their creative genius, and by their power and faculty of applying science, have made this city illustrious, and have conferred untold benefits upon the district, upon the country, and upon the world. I sincerely hope that the Corporation of Newcastle-upon-Tyne will never prove itself unworthy of this noble heritage, and will never fritter away these great advantages. Corporations need watching. There is a spirit in the air to municipalise everything, to enter into enterprises foreign to the purposes of municipal government, and entailing enormous financial risks upon the ratepayers, and at the same time striking a deadly blow at individual effort. I can conceive of no body of gentlemen who ought to be more sensitive to the insidious approach of this doctrine than you, for if left unchecked it will speedily invade your own special domain. And therefore it behoves all thoughtful men to give every attention to these developments, and at the same time to bring their educated thought and opinion to bear upon all these municipal schemes and deliberations. The recent Education Act has invested our municipal bodies with fresh powers. It has been said, both inside and outside, that the City Council has neither the capacity nor the time to undertake these duties. I regard both the excuse and the charge as invalid. But this I venture to hope—that these enlarged powers of usefulness will attract men of position, of intelligence, to the City Council, and that whilst they may not find a congenial sphere for their talents in drains and sewers, in sanitation, and other cognate subjects, or even in Quay extension, they will be able to throw their

educational enthusiasm into those schemes, especially of higher and technical education, which are so necessary to equip the rising generation and the young men of our time with that training which will enable them in the future to maintain our pre-eminence in the manufacturing world.

This concluded the toast list, and during the remainder of the evening the members and their friends indulged in social intercourse.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.

NINETEENTH SESSION, 1902-1903.

PROCEEDINGS.

FOURTH GENERAL MEETING OF THE SESSION HELD IN THE LECTURE THEATRE OF THE LITERARY AND PHILOSOPHICAL SOCIETY, WESTGATE ROAD, NEWCASTLE-UPON-TYNE, ON FRIDAY EVENING, JANUARY 23RD, 1903.

JOHN TWEEDY, ESQ., J.P., PRESIDENT, IN THE CHAIR.

The SECRETARY read the minutes of the previous meeting, held at Sunderland on Friday, the 12th of December, 1902, which were confirmed by the members present and signed by the President.

The PRESIDENT appointed Mr. A. E. Long and Mr. J. H. Pescod to examine the voting papers for new members, and the following gentlemen were elected:—

MEMBERS.

Dickie, Matthew D., Ship Draughtsman, Falston House, West Park, South Shields.

Taylor, Martin B., Shipbuilder, 18, Laburnum Avenue, Wallsend-on-Tyne.

GRADUATE TO MEMBER.

Wood, Lionel, E. Engineer, 4, Simonside Terrace, Heaton, Newcastle-upon-Tyne.

GRADUATES.

Darby, Harold, E. Draughtsman, Park House, Church End, Finchley.

Denton, G. P., S. Draughtsman, 63, Osborne Road, Newcastle-upon-Tyne.

Lovatt, John James, E. Apprentice, 15, Kingsley Place, Heaton, Newcastle-upon-Tyne.

Slee, Herbert Teal, E. Apprentice, 37, Grosvenor Place, Newcastle-upon-Tyne.

Vick, Henry Hampton, S. Draughtsman, 19, Fern Avenue, Jesmond, Newcastle-upon-Tyne.

THE INSTITUTION GOLD MEDAL.

The PRESIDENT said—I am sorry to observe that Mr. D. B. Morison is not present to-night. If he had been present we would have had the pleasure—I am sure it would have been a great pleasure—of presenting him in person with the Engineering Gold Medal of the Institution. The Council has decided that Mr. Morison has earned—with some over-plus—this medal, for his papers on "The Unsatisfactory Condition of the Engineering Branch of His Majesty's Navy." We all know the result of the efforts which have been made in this district, and I am sure to no one outside the Admiralty is more credit due than to Mr. Morison. In his absence, I have to request that the Secretary will convey this medal to Mr. Morison with the heartiest thanks of the members, associates and graduates of the Institution and with their best wishes for his health and prosperity. I may say, in this connection, that I have received two very interesting letters on this subject, both written by experienced men holding important positions in H.M. Navy. Both letters express the feelings of a great number of the colleagues of these gentlemen. The tone of the letters is most complimentary to the North-East Coast Institution of Engineers and Shipbuilders. The writers are most grateful for the assistance the Institution has been able to give. They convey to the members the compliments and warmest thanks of the engineer officers of the Navy for the splendid work done by this Institution in helping to bring about a great reform.

Mr. JOHN H. HECK replied to the discussion on his paper on "Fire Extinguishing Apparatus for Ships."

The discussion on Mr. J. HAMILTON GIBSON'S paper on "Large Stop Valves for High-pressure Steam" was resumed and adjourned.

Mr. JOSEPH H. PESCOD read a paper on "Minimum Metacentric Heights in Small Vessels."

MR. JOHN H. HECK'S REPLY TO THE DISCUSSION ON HIS PAPER ON "FIRE EXTINGUISHING APPARATUS FOR SHIPS."

Mr. JOHN H. HECK replied to the discussion on his paper on "Fire Extinguishing Apparatus for Ships." He said—In my opinion the discussion appears to confirm the view put forward in the paper, viz., that something more than water or steam is required to cope with fire at sea; and of the various arrangements I know, the sulphur-dioxide machine seems to be the most efficient for extinguishing fires of large dimensions at sea.

In reply to Mr. Andrew, a small quantity of the gas, from two to three per cent., mixed with ordinary air, would probably be fatal to life. It, however, would depend upon circumstances.

An escape of the gas into the engine-room, owing to the draught and ventilation caused by the boiler fires, would, in my opinion, not do much harm; besides, the entry of gas, owing to the bulkheads, could only be of a small amount.

An entry into the cabins might be of more serious consequence. In the case of a fire of large dimensions, however, the passengers could be called on deck and removed to other quarters.

In reply to Mr. Withy, Mr. Stewart and Mr. Adam have already given, in their remarks, what reduction or allowance in the premium for insurance of the hull some companies have given to vessels fitted with the SO_2 machines. In regard to cargo, it is, I believe, a matter of arrangement.

It would not do to enter any hold which contained a gas-laden atmosphere before some hours had elapsed, in fact, until the atmosphere was purified and the temperature lowered. This could be effected in about 12 hours.

It would be of value to close the ventilators when forcing the gas into the holds, even although the gas is about $2\frac{1}{4}$ times heavier than air. The cost of fitting the machine would be about £400, and the machine is suitable for vessels from 3,000 to 5,000 tons. I agree, of course, with Mr. Withy that for larger vessels a larger machine should be used.

Mr. J. Stewart has added, by his remarks, considerable value to the paper, and for that reason I am much obliged to him. He knows the machine, and what he has said is from personal knowledge and experience.

The same applies to Mr. Adam's remarks. His description of the disinfecting of the "City of Perth" is very interesting, and his general remarks also supplement the paper on various points which had been omitted.

Mr. C. Wilson is perfectly right in saying that SO_2 is a very unpleasant thing, and for that reason it is necessary to keep it under control. I cannot help thinking that in the vessel to which he refers the bulkheads cannot have been tight, or else it must have had some sluice valves which had been opened or left open. This apparatus can be made to ventilate any space, so that if any gas leaks in where its presence is not required, it can be removed. Mechanical ventilation is a very satisfactory method of dealing with a cargo which gives off any gas, so as to prevent any danger or unpleasantness to any one on board.

The President's remarks and description of the experiments made in France by Dr. Calmette of the Pasteur Institute of Lille, in connection with the destruction by SO_2 of germs of plague, cholera, and other diseases, are very interesting. I am glad that they appear in the discussion.

Mr. Chaston fully confirms what appears in the paper as to the effect of steam in damaging cargo when it is employed to put out fire. I have already given the cost of the machine and fittings, and will in accordance with Mr. Chaston's request append a list of the vessels fitted with the SO_2 machine.*

I must thank Mr. J. Denholm Young for his description of the fire extinguishing apparatus fitted on board the school-ship "Conway."

Mr. Evans' remarks are in the form of an explanation, so there is no need to say anything in reply.

I agree with Mr. Laws that the slowness of action of water and steam on board ship when used for extinguishing fires has caused much monetary loss in the case of certain cargoes which have not even been touched by the fire itself.

* See page 97.

In replying generally it may be pointed out that the apparatus may be used in putting out fire, disinfecting, and ventilating a ship.

It appears to me that if vessels had this apparatus, or some similar apparatus, it would be a safeguard against fire, and the holds could be disinfected effectually whenever an opportunity offered, and thus lessen very greatly the danger of conveying disease from one place to another.

It is well known that in cases of infectious disease, houses are disinfected by liquid SO_2, and I cannot help thinking it would do much good if dwellings, conveyances, large halls, etc., were occasionally disinfected. It would in my opinion effecually prevent the spread of any epidemic.

I have to thank you for the attention which you kindly gave to the reading of the paper.

The PRESIDENT—I am sure it is your wish that we should convey to Mr. Heck our warmest thanks for the valuable paper he has read, and for his interesting reply to the discussion upon it. The paper is an admirable paper in many respects. First Mr. Heck tells us what the usual appliances consist of, pointing out some of their defects, and then he sketches out improvements which have recently taken place, so that we shall now have before us in the Proceedings of the Institution a fairly complete history of fire apparatus on board ship. I am sure it is your wish that I should convey to Mr. Heck the heartiest thanks of the Institution for the trouble he has taken in writing this paper, and reading and explaining it.

The motion was carried by acclamation.

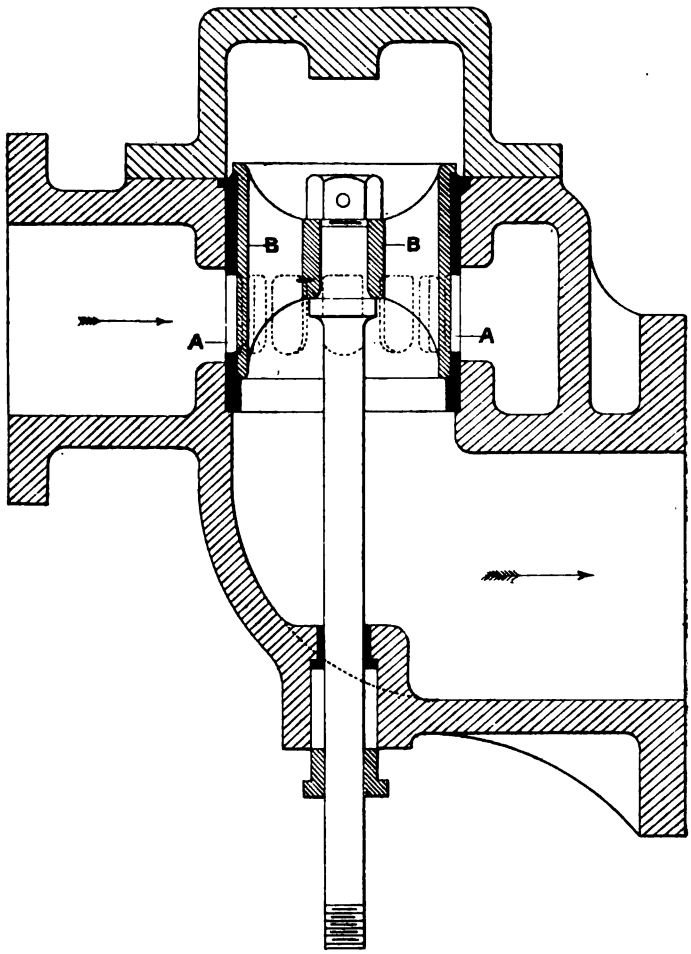
VESSELS FITTED WITH THE CLAYTON FIRE EXTINGUISHING APPARATUS.

Name.	Owners.
"Ashmore," s.s.	Adam S.S. Co., Aberdeen.
"Abergeldie," s.s.	,, ,,
"Aberlour," s.s.	,, ,,
"Turakina," s.s.	New Zealand Shipping Co. London.
"Wilhelmine"	H. H. Schmidt, Esq., Hamburg.
"Celtic Monarch"	R. Huges Jones & Co., Liverpool.
"Carnedd Llewellyn" ...	,, ,,
"Ama Begonakoa"	Sota & Aznar, Bilbao.
"Fennia"	J. W. Soderlund, Raumo.
"West Lothian"	J. Boyd, Glasgow.

RESUMED DISCUSSION ON MR. J. HAMILTON GIBSON'S PAPER ON "LARGE STOP VALVES FOR HIGH-PRESSURE STEAM."

The discussion was resumed on Mr. J. Hamilton Gibson's paper on "Large Stop-Valves for High-Pressure Steam."

The PRESIDENT said—I would like to remark that there is one form of steam stop-valve that Mr. Gibson has not referred to and which, I think, lends itself to the application of a flexible face. It is a stop-valve of this kind:—



SKETCH F.

We have used such valves for many years, and find that although, when new, the valves are occasionally not quite tight, yet as a rule they work with perfect satisfaction. The advantage of this valve over some others appears to be that the liner, A, and valve, B, being of the same material and being subjected to exactly the same temperature, the expansion of the two parts is practically identical.

Mr. Edwin Griffith said—I would like to make a few remarks regarding this paper, which, I think, will be appreciated mostly by those who have had to meet Admiralty high-pressure requirements during the last ten or fifteen years. It is obvious that that is what led to the development of the valve described, and also to the paper being written at all. Even in the days of 155 pounds pressure we had quite enough trouble owing to the causes which are indicated in the paper, and when the pressure was about doubled all at once, our troubles were not lessened, of course. There is a reference in one part of the paper to the fact that the ribbing of valves does not cure the trouble. I remember a case where it actually aggravated it. We could not possibly get through the Admiralty tests satisfactorily, and we cast new valves heavily ribbed, the result being they were quite tight opposite the ribs, but appeared worse than before between the ribs. So I think anyone who has to do with high pressures had better avoid ribs in valves.

There is a calculation in the paper indicating what size of hand wheel would be required to overcome the friction alone in a particular case, but there seems to be an omission in the calculation, namely, that the friction of the screw is ignored altogether. The only friction taken into account is the friction of the nut on the boss of the cover. That is rather curious, because the author goes on to remark upon the great importance of the friction of the screw a few sentences later.

Then there is a paragraph about the practice on some of the ocean liners. Mr. Gibson says: "Some engineers, with a faith that would remove mountains and a splendid disregard of expense and complication, if only the ultimate object can be attained, have tried the infinite power method; as, for instance, in some of the great ocean liners, where the main regulating-valve is actuated by a special separate steam engine driving

worm-gearing." What I was accustomed to was to adopt a steam and water donkey to act direct on the spindle. That is the forced method, but it is a handy way of applying the force; not a costly way, either, having regard to the importance of the matter and the advantages secured. It has several conveniences. You only need to manipulate the small valves of this small donkey, which can be done most easily. The handle is readily and quickly worked. You can give it the whole travel almost instantaneously, and the position of the lever indicates what amount the valve is open. Then another very important advantage is that the governor may actuate the small donkey's valves and in this way the main regulating-valve can be controlled by the governor. This method, for instance, is in use on the s.s. "Campania" and "Lucania," and has given great satisfaction.

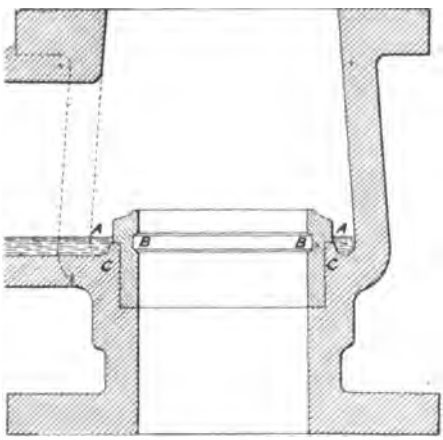
Mr. George Cockburn (by invitation of the President) said—I left Glasgow this morning in order to be present at the discussion of Mr. Gibson's paper on stop-valves, my only excuse for coming so far being my intense interest in the subject.

Since the introduction of high pressures and superheated steam many problems have evolved requiring consideration of the whole question, and it is to be hoped Mr. Gibson's paper will excite greater interest in the matter.

The first consideration in designing a stop-valve is its safety. For example, several years ago our firm made a stop-valve for a factory. It contained no provision to compensate for the contraction of the spindle but was made in the ordinary way. It was fitted as an intermediate stop-valve with the spindle in the horizontal position. The stop-valve on the boiler was shut and the intermediate valve was also shut. The end of the range of pipes was open into a tunnel in which several men were working re-jointing pipes. All at once a volume of steam and water was discharged at the open end of the pipe and unfortunately severely scalded three men in the small tunnel. This was caused by reason of the stop-valve on the boiler not being steam-tight and steam condensed in the pipe between the two valves. The water gradually accumulated in the pipe till it submerged the horizontal spindle of the intermediate valve, thus cooling it and contracting it sufficiently to remove the valve a little from the seat, with the result described. This valve kept opening and

closing at intervals of two hours. It is obvious when the water was blown out, the spindle expanded and shut again on coming in contact with the hot steam.

This accident is only one of a great number on record that could be cited, showing the importance of constructing large stop-valves so that the spindles shall be free to expand and contract with the varying temperatures to which they are exposed. If these valves had been fitted with the system of diaphragms and valves as shown on Mr. Gibson's plan an accident from the foregoing cause would have been impossible, as the diaphragm would have immediately responded to the diminishing length of the spindle.



SKETCH G.

Another very good feature about Mr. Gibson's stop-valve is that the brass seats are not driven into the cast-iron or steel chests as is the usual practice, but are secured on a flat surface free to expand or contract. The importance of this will be better understood by referring to Sketch G. For example, when a valve seat is driven hard into a recess formed in the valve chest when cold, the valve seat requires to be re-ground owing to the face becoming distorted. When this is done the valve is perfectly tight under cold water pressure and even under steam pressure it may be tight. But if the valve is opened and steam allowed to enter the upper part of the valve chest this steam condenses into water at a much lower temperature than the steam and runs down the inside wall of the valve box into the part marked *A*. This keeps gradually cooling a strata of metal at the part *C*, which contracts the hole for the reception of the seat to such an extent that practically all the expansion due to the heat is lost. Thus, in estimating the amount of strain on a valve seat due to the compression of of the brass forming it, no allowance for expansion should be

made for the hole in the chest in which the seat is to be fitted. In other words, the condensed water cools the metal surrounding the upper part of the seat and contracts it to such an extent as to distort the face of the valve seat and thus start a leak which keeps the condensation alive. After the seat is driven in, a groove cut at B has the effect of diminishing the seat's power of resistance at that part and takes up the distortion due to expansion and contraction before it reaches the higher level of the face of the valve seat. Valves treated in this way are quite tight under all conditions. But I do not approve of driving in seats for another reason, and that is, the seats of large valves become slack in a very short time in consequence of being frequently compressed, and leak accordingly. If a finished stop-valve chest be taken and put into a stove heated to a temperature of, say, 600 degrees and allowed to remain there till uniformly heated, then if a little water be sprinkled on the inside walls of the chest and allowed to run down in imitation of what takes place in practice it will be observed that at first the water boils violently but as more water is added the boiling stops. During this process the recess for the valve seat gradually contracts to very nearly the diameter when cold. It is the experience of every superintendent engineer who has safety-valves of the Board of Trade type with driven in seats under his supervision that the valves are tight under steam till they blow-off, but they will not shut till far below the working pressure. This is due to the same cause, viz., condensed water contracting the hole into which the valve seats are driven. On the other hand, the same valves, if made to blow direct into the atmosphere without casings to induce condensation, would be quite tight. Frequent re-grinding of the valves is no use, as fresh crops of irregularities appear on the surface of the seat face.

The effects of condensed water on the parts of apparatus using high-pressure steam presents a wide field, almost unexplored, for research, and I am pleased to see such a large proportion of young members taking an interest in the work of the Institution, thus qualifying themselves to take up the more intricate problems connected with the engineering profession which are sure to come up in the future. Mr. Gibson in his paper suggests that main stop-valves for boilers might be

greatly reduced in diameter without diminishing their efficiency. We frequently supply valves varying in size from 8 inches to 3½ inches diameter for the same amount of fire grate and pressure. Large Belleville boilers are usually fitted with stop-valves 3 inches diameter, the inlet being 2 inches diameter and the steam branch 2½ inches diameter. Could a safe standard not be fixed by experiment and thus save an enormous waste of material? Economy is an important factor, so that there is room for some attempt at standardizing.

One typical case illustrating this view came under my observation not many years ago. A stop-valve of the pilot type was fitted in connection with a set of large engines. The steam enters on the top side of the main valve about 9 inches diameter, pressure 180 pounds, and on the spindle is secured a small pilot valve 2½ inches diameter. The ship went through her trials to the satisfaction of the owners and ran the measured mile within contract time. But on comparing the indicator diagrams with those of a previous sister ship it was found that there were indications of a little wire drawing of the steam, and the revolutions were one or two less. The responsible engineer got instructions to examine the stop-valves at the first port of call and on doing so found that the nut on the pilot valve, securing it to the spindle, had become detached. Under these conditions the pilot valve only lifted and could only admit steam equal to 4 square inches area into the engines. Taking this circumstance into consideration there seems room for profitable enquiry into this subject.

In conclusion I have to thank the President for his kindness in asking me to make a few remarks on the valuable paper read by Mr. Gibson.

Mr. H. L. Riseley said—I have not read the paper very carefully, but there is one point I think I might call attention to, namely, there has been no mention made of parallel slide valves. Although I have not had much experience at sea I have had a varied experience on land and am pretty well acquainted with the various types of valves used in land practice. In my opinion all stop-valves should have cast-steel bodies. I remember a place where all stop-valves used were of American cast-iron, and of wedge type, and a very serious accident nearly occurred through

a bonnet being blown off, coming clean away from the studs. In this case it was due to water getting into the pipes, caused by an engine being suddenly started and thus causing the boilers to prime, the water hammer undoubtedly causing the trouble. Needless to say all these valves were scrapped.

I know of a case in London where a lighting station was completely shut down for some considerable time owing to the fact that valves of a faulty design were used. In this case the valve was of the ordinary sluice type only the wedge was in two pieces and kept up to the face by means of a fixed wedge on the end of the valve spindle. As there had been no proper allowance made for expansion it was sometimes impossible to move these valves when they were shut and *vice versa.*

The conclusion I have come to is that the very best valve now on the market for land purposes—I cannot say for sea practice—is a parallel slide valve having a cast-steel body as shown on Plate XV.

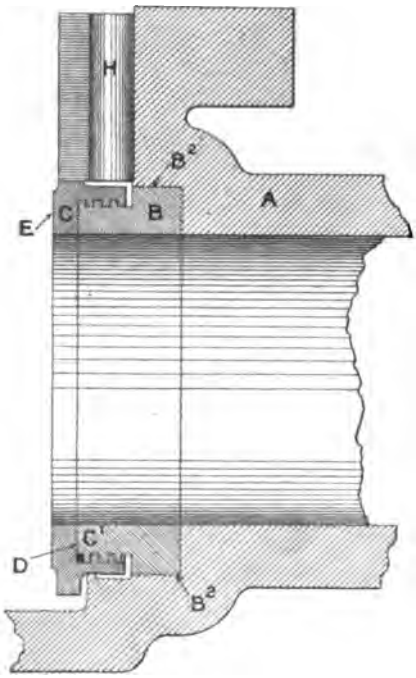
The advantages of this type of valve is that it gives an uninterrupted passage for the flow of steam equal to the diameter of the pipe.

The valve is held up to its works by means of a spring, and on opening and closing, the slide is held on the seat with a uniform pressure. Dirt cannot get between the valve face and the seat, and thus the scoring of faces is avoided. As regards the springs it is essential that steel springs should be used where superheated steam is employed, as phosphor bronze springs soon lose their elasticity.

The valve can never jamb because the expansion spindle is fitted with a crosshead which comes against stops on the guide spindles before the valve is right home.

Another great advantage of this type of valve is the extreme accessibility of the various parts for repairs. This is clearly seen on Sketch H. *A* is the body of the valve, being of cast-steel. *B* is a ring of cast-steel, and is fitted accurately and forced in by hydraulic pressure into the recess B_2; on the projecting end a square thread screw is turned, and over this is fitted a gunmetal seat, *C*. Both pieces *B* and *C* are well fitted and a perfect joint is made at *D*. The facings at *D* are capable of expanding sideways, as the gunmetal ring, *C*, is not firmly fixed laterally; therefore it cannot buckle or become leaky notwithstanding

great variations of pressure and temperature. *E*, is the gun-metal face on which the valve works. *H*, is a key to prevent *C* becoming unscrewed. The seat is easily removed by withdrawing this key and can be faced up without dismounting the valve.



SKETCH H.

At Wallsend we have a great number of this type of valve at work at a pressure of 200 pounds per square inch, with a superheat of about 150° Fahr. at the boiler stop valve, and although they have now been in operation for more than two years they have practically given no trouble at all.

I should say we have between sixty and seventy valves in use, varying from 5 inches to 8 inches in diameter, and we have never had to take a valve out yet, neither have any of the valves had to be faced up, and the packing round the spindle remains as good to-day as when they were first put in.

The discussion stood adjourned until the next meeting.

MINIMUM METACENTRIC HEIGHTS IN SMALL VESSELS.

By JOSEPH H. PESCOD, Member.

[Read before the Institution on January 23rd, 1903.]

The stability question is one which has been the subject of many papers read before this Institution, so that some of the observations the writer may make during this paper must of a necessity have appeared before.

The consideration and study of stability of small cargo vessels it is to be feared is much neglected, very little data being obtainable of the G.M. or metacentric heights of the various types of those in existence. The majority of large shipyards in this country incline their vessels when completed, and prepare metacentric diagrams. The construction and careful study of this diagram with its accompanying information are indispensable to the preparation of well considered designs of cargo and other vessels, the calculations involved being very simple. In yards where the majority of small vessels are built, the drawing office staff not being large, the preparation of this diagram, and the necessary inclining experiment, with the subsequent calculations for the metacentric heights of any vessel in those conditions in which she is likely to be placed, in that particular trade in which she will be employed are rarely carried out. The preparation of stability curves also, which alone show the variation of the statical stability at different angles of heel, and which take some time to prepare is, on account of cost and perhaps because they are thought unnecessary, dispensed with.

The designs of these crafts, we must therefore conclude, are based not so much on scientific knowledge of their stability as on experience of previous vessels, and it would be well if more attention was given to this essential element of a vessel's seaworthiness. The writer recently made some investigations

into the stability of several small vessels; the summary of the results of which, notwithstanding the fact that there are few firms building these types in this district, may prove of interest to the members of this Institution and create an useful discussion.

Metacentric diagrams shown on Fig. 2 (Plate XVI.) were prepared for the following classes of ships:—

1. Coasting Vessel.
2. Fish Carrier.
3. Collier.
4. Torpedo Boat Destroyer.

The midship sections of these are shown on Fig. 1 (Plate XVI.), and it will be seen that there is a wide difference in the types chosen.

The first three mentioned vessels were inclined to obtain their respective positions of the centre of gravity in the equipped condition and calculations were afterwards made of their metacentric heights loaded and stability curves constructed based on this latter condition.

The first vessel, whose diagram and section are marked 1 on Plate XVI., is one which foundered on her maiden voyage while at sea in moderately calm weather, and whose loss was said to be attributed solely to want of stability in the condition she was then loaded.

The principal dimensions, and particulars of this vessel are as follows:—

Length, B.P.	135 feet.
Breadth, moulded	21 ,,
Depth	11 feet 10 inches.
Depth of hold	9 feet 3 inches.

She was built to carry a deadweight of 300 tons on a mean draft of 10 feet 10 inches, Lloyds' freeboard being 13½ inches.

She had a raised quarter deck 2 feet high over the machinery space which was aft, the deck casing around engine and boiler space was 7 feet high. She had a topgallant forecastle and a cellular bottom 32 inches deep (Lloyds' minimum depth), constructed under the cargo hold for carrying water ballast. Her cargo hatches were exceptionally large.

This unfortunate vessel, on her first and only loaded voyage, carried a coal cargo, which was said to have been properly stowed

and practically filled all her cargo space with the exception of a small space at fore end of the hold under the upper deck; the metacentric height in this seagoing condition was stated to be 9 inches, and the values of the G.M. in the ballast, and equipped conditions were 1·6 and ·17 feet respectively. The evidence of the behaviour of this ship previous to her loss shows her to have been tender; she would steam along with a list to port for 5 or 10 minutes or sometimes for half an hour, then gradually heel over to the starboard side for a similar period of time, and that she never sailed upright after leaving port. At this time there was probably about 2 tons of water in the well, the movement of which would certainly account for her behaviour owing to her tenderness. There was said to be no water in the ballast tanks, these having been sounded, and found to be practically dry.

The putting over of the rudder to either port or starboard 2 or 3 degrees was also observed to heel the vessel.

She eventually took a small permanent list to starboard of about 5 degrees, and while in this condition was struck over the forecastle by 2 or 3 small seas, which heeled her over suddenly until her quarter deck rail was under water. She lay at this inclination, apparently not having stability to right herself, water poured through the casing door to the engine room, and filled the machinery space. The wind, which was rather strong, was on the port bow at this time. This latter angle of inclination was so large that it allowed of the port lifeboat being launched on the starboard side. The vessel then sank by the stern.

Referring to Fig. 3 (Plate XVI.), No. 1 is the curve of stability of this vessel, based on the position of centre of gravity, which gives a metacentric height, loaded, of 9 inches, and includes the stability afforded by the forecastle and cargo hatches.

The dotted part of the curve from 36 degrees shows the form the curve would take if we included the effect of the high casing to the engine space, but as the casing door already mentioned was not watertight, and water would lip over the sill at 36 degrees. The correct method of course is to include the effect up to this angle, and for further inclinations to neglect the casing, a step being thus formed in the curve.

This curve shows the maximum righting moment to be 183 foot-tons—the leverage being ·30 feet at an angle of 36 degrees—

with a load displacement of 612 tons. The range of stability is 73 degrees.

Heavy permanent lists of vessels are usually caused by the cargo shifting, but in this case the vessel met with no heavy weather. The cargo practically filled all the cargo space, and only in exceptionally heavy weather does a coal cargo shift; the angle of repose of coal being between 28 degrees and 32 degrees. As the vessel's first permanent list was only 5 degrees, it is, therefore, hardly possible that her final inclination was due to this cause.

Again, if there had been a large amount of water in the ballast tanks due to leaky valves, the cellular bottom intercostals would break the flow of water, and prevent it moving quickly to one side, thus giving her a sudden inclination.

Curve 2 (Fig. 3, Plate XVI.) is that supposing she were loaded so as to give 1·8 feet metacentric height, which the writer suggests is what the minimum should have been for seaworthiness, the reasons for which will be stated later.

The dimensions and particulars of the second named vessel are: —

Length, B.P.	135 feet 4 inches.
Breadth, moulded ...	21 feet.
Depth, moulded	12 feet 1½ inches.
Loaded draft	11 feet 1 inch with 6 inches bar keel.
Freeboard	19½ inches.
Load Displacement...	565 tons.

She has flush deck, turtle back forward, good sheer forward and aft, and is built on the ordinary transverse frame system with no double bottom. She was originally designed, and employed as a fish carrier, and had about 60 to 70 tons of cement slag, etc., cemented between the floors, which served the double purpose of ballast, and ceiling for a fish cargo.

Her dimensions are those generally given to the larger class of trawlers built on the coast, whose dimensions are 115 feet by 21 feet by 12 feet and of whose stability she would be a fair example. When fully loaded the metacentric height is 3 feet, and she was said to be a splendid vessel in a seaway. When light, the value of the G.M. is 3 feet.

Some years ago this vessel changed owners, the cement

ballast was removed, as it was intended to employ her as a general carrier, her metacentric height now, if loaded with a homogeneous cargo filling all the cargo spaces, is 2 feet, and in her equipped condition 1·9 feet.

The curve of stability 3 on Fig. 3 (Plate XVI.) corresponds to her original loaded condition, showing a maximum righting moment of 723 foot-tons at an angle of 40 degrees, the leverage being 1·28 feet, and the range of stability 74 degrees.

The curve 4 (Plate XVI.) is that in her present loaded condition with a maximum righting moment of 367 foot-tons at an angle of 35 degrees, the leverage is 65 feet. whilst the range of stability is 63 degrees.

Her midship section is marked 2 on Fig. 1 (Plate XVI.), and the metacentric diagram 2 on Fig. 2 (Plate XVI.).

Comparing the metacentric diagrams of Nos. 1 and 2, it will be seen the curve of metacentres is much higher in No. 2 than in No. 1, although the dimensions are practically the same, whilst the displacement of the former is about 65 tons less than that of the latter.

No. 2 has a larger rise of floor, this being 2 feet against ·5 feet rise of floor of No. 1, the locus of the centres of buoyancy is higher, as shown on the metacentric diagram.

Again we have an increase in the height of metacentres above the centres of buoyancy over No. 1. This quantity, as we know, is obtained by dividing the moment of inertia of water plane transversely by the volume of displacement in cubic feet, and as No. 2 is slightly broader than No. 1 at the load water line, as will be seen on referring to their midship sections, and as the displacement of the former is less than that of the latter, the foregoing three elements give a total increase of about ·7 of a foot in the height of the metacentres above the base of No. 2 over those of the corresponding heights of No. 1.

The centre of gravity of cargo of No. 2 is lower than that of No. 1, owing to the latter having a cellular bottom 32 inches deep whilst the former has only ordinary floors 13 inches deep. The cargo is thus stowed much lower than in No. 1.

The centre of gravity of the equipped vessel is also lower for No. 2 owing to No. 1 having a raised quarter deck, high casings and a forecastle.

The curves of stability of Nos. 1 and 2 show that whilst the levers of No. 1 are much smaller than those of No. 2 the range of stability is larger. This is due to the favourable effect the forecastle, hatches, and raised quarter deck of No. 1 has upon this part of the curve, No. 2 being flush decked and having none of these erections.

It may be said that No. 1 had possibly not 9 inches G.M. in the loaded condition, but knowing the different phases of this case the writer considers this figure to be somewhat near the mark.

The third example is that of a collier, whose load displacement is 2,300 tons, or about four times that of the two previous examples, and is practically an enlargement of No. 1 type of vessel.

Her dimensions are:—

Length B.P.	220 feet.
Breadth, moulded	32 feet.
Depth, moulded	17 feet.

Her load draft is 15 feet 9 inches with 8 inches bar keel, the freeboard being 2 feet 1½ inches.

She has a raised quarter deck 3 feet high, a bridge, and forecastle, the total length of which erections exceed two-thirds of her length between perpendiculars. She is fitted with a cellular bottom.

Laden with coal, which corresponds to the condition of being loaded with homogeneous cargo filling all cargo spaces, the G.M. is estimated to be 11 inches, and she has been traded in this loaded condition over 15 years.

This vessel is known to be tender and has to be handled with great care.

The curve of stability shown by 5 on Fig. 3 (Plate XVI.) is more favourable than that of 1, with which it closely corresponds in form.

The maximum righting moment is 1,173 foot-tons at an angle of 35 degrees, the leverage ·51 feet, the range of stability 78 degrees; and the righting moment at an angle of 35 degrees is about 6 times that of example 1.

No. 4 is included among these examples on account of the extremely good curve, and range of stability this type of warship possesses. The seaworthiness of vessels of this class has

been much discussed of late owing to their supposed lack of rigidity when in a seaway, it cannot be said, however, that they are stinted as regards stability.

The dimensions of this design which are based on those of vessels already in service are:—

Length on L.W.L.	230 feet.
Breadth, moulded	23 feet.
Depth, moulded	14 feet 6 inches.

The normal displacement is 400 tons on a mean draft of 6 feet. She was designed with a freeboard of 8 feet 6 inches and the metacentric height in the normal seagoing condition is 2·66 feet. There would only be a slight alteration in the G.M. in any sea service condition.

The position of centre of gravity is approximated from actual ships inclined and which possess from 2 feet to 3 feet metacentric height.

The metacentric diagram No. 4 on Fig. 2 (Plate XVI.) is of an unusual form owing to the peculiar underwater lines of Torpedo Boat Destroyers.

In fixing upon the metacentric height of these vessels an allowance is made for the possible loss of initial stability, etc., due to any compartment becoming filled with water, if bilged, or riddled during action.

The curve of stability shows a maximum righting moment of 520 foot-tons, the leverage being 1·3 feet and range of stability 89 degrees, and the influence of the large freeboard is evident.

From the foregoing cases will be seen the great danger of unduly diminishing the metacentric height as in No. 1, and the necessity of having standard rules for regulating these minimum values of initial stability for different types. There are no steamers afloat, whatever their tendency towards instability may be in certain circumstances, that could not be kept perfectly safe, if treated with a full knowledge of what their stability really is, and it would be well if in fixing these we erred on the safe side, especially in small vessels, and so allowed a margin.

It is obvious that in judging of the safety of a small metacentric height, the range, and amount for seaworthiness are the important factors, as these largely determine the limit below which the metacentric height should not be reduced.

The righting moment of a vessel being represented at any angle of heel within her range of stability, by the product of her displacement into the leverage of statical stability or G.Z. corresponding to that angle, it follows that the smallness of the displacement of examples Nos. 1 and 2 makes them more liable to be easily inclined by movement of cargo, weights on deck which may move, movement of water on well deck, or the action of external forces in a seaway, such as wind pressure, and wave motion.

Similar causes would probably have little effect on large vessels with the same leverages of stability.

The resistance of vessels to being suddenly inclined to any angle by a blow from the sea, or to use the technical term, the dynamical stability, is proportional to the above named product; reasoning from this, it follows we should give vessels of small displacement, such as those examples before us, an increased metacentric height over that we would consider sufficient for a vessel which has a displacement ten or twenty times that of Nos. 1 and 2.

The subject of minimum metacentric heights is treated in a very diplomatic way in the various text books on stability, no direct statement of figures as standard values of G.M. is given, it being only stated generally that cargo vessels loaded with homogeneous cargoes have been found to possess metacentric heights of ·7 to ·8 of a foot, whilst others have had 1½ to 2 feet, and that some types cannot carry such cargoes without ballast whilst large ocean-going passenger steamers with metacentric heights of from 1 to 2½ feet have gained high reputations for steadiness.

In the case of vessels similar to the examples given, with small displacement, those on board can observe if they become unduly tender towards the finish of their loading, but such tenderness would not exist in average sized vessels with greatly increased displacement and the same metacentric height.

The dynamical stability of No. 1 example at an angle of 36 degrees is estimated to be 75 foot-tons.

In the event of carrying grain cargoes an increase in the G.M. would be required over that considered safe for immoveable cargoes, so that large steady inclinations could not be produced and so cause the grain cargo to shift and give the vessel

a list, which would gradually increase, and cause the vessel to be abandoned.

The other factor of the righting moment, *i.e.*, the lever of statical stability at any angle of heel beyond that at which the metacentric method holds good, depends greatly on the freeboard the vessel possesses, and to this we should attach the greatest importance, bearing in mind the value forecastles, poops, and such deck erections have in increasing the length of levers, and extending the range of the stability curve.

The minimum freeboards of vessels loaded, as is well known, is assigned by the Board of Trade, and aims at obtaining the reservation above water of a regulated minimum percentage of the total buoyancy of the vessel.

This percentage of reserve buoyancy varies considerably according to the increased dimensions, length and depth of vessel. For a steamer about the size of Nos. 1 and 2 examples it is 22½ per cent., and gradually increases according to larger dimensions. For a vessel 450 feet long and 38 feet depth moulded, it is 35½ per cent., so that small vessels have assigned to them comparatively less freeboard.

The freeboard of a vessel, or the angle at which the deck becomes awash, has the greatest influence on a stability curve when associated with a high centre of gravity, and the smaller the freeboard the greater should be the metacentric height.

To illustrate this comparative difference in freeboards, the writer has estimated the angle at which the deck is awash from actual cargo vessels of different load displacements, to be as follows:—

Vessel of	12,000	tons	load displacement	17	degrees.
„	10,000	„	„	14	„
„	8,000	„	„	13	„
„	4,500	„	„	12	„
„	2,800	„	„	10	„
„	No. 1 example,		„	6	„
„	2	„	„	9	„
„	3	„	„	10	„

These, with the exception of No. 2 example, have either poops, bridges, forecastle, and raised quarter decks, the total lengths of which are somewhat in proportion to the different lengths between perpendiculars.

In large cattle steamers fitted with shelter decks, of which type of vessel there has been a considerable number built of late on this coast the shelter deck is not awash till about 29 degrees.

At angles of inclination beyond that at which the deck is awash the outward movement of the centre of buoyancy is decreased, and we have consequently smaller levers, and usually less range of stability.

The following Extract is taken from the Instructions to Surveyors in the Freeboard Tables:—

"In framing these tables, it has been assumed that the relation between breadth and depth is such as to ensure safety at sea with the freeboard assigned when the vessel is laden with a homogeneous cargo; for vessels of less relative breadth, the freeboard should be so increased as to provide a sufficient range of stability, or other means adopted to ensure the same."

This latter clause we assume means that the vessel should be so loaded as to have sufficient metacentric height to ensure seaworthiness.

There is also a note that states the necessity of a liberal amount of freeboard in flush decked vessels which are deprived of deck erections; that is, No. 2 should have more G.M. than No. 1.

It is generally recognised by shipbuilders that the metacentric heights loaded of the average sized cargo vessels should not be less than ·8 of a foot provided this gives about the same length of leverage of stability at angles of 30 to 40 degrees, whilst some designers fix the higher value of one foot as their minimum, exceptions to these standards being that of vessels conveying cargoes that are liable to shift.

The stability curve marked 7 on Fig. 3 (Plate XVI.) is that of a cargo vessel of 4,500 tons displacement which has the above values, *i.e.*, ·8 feet metacentric height, and ·8 of a righting lever at 58 degrees.

To attain this leverage of ·8 of a foot example No. 1 would require to have a G.M. of 1·8 feet, and example No. 2, 2·3 feet.

From the foregoing it will be seen that G.M. is imperfect by itself, and may be misleading as regards stability at large angles, and also that a serious error arises in assuming the same standard of metacentric height for all sizes of cargo vessels.

The assumption that to prevent rolling and thus attain steadiness in a seaway, a small G.M. is preferable, cannot be put forward in the case of these vessels, owing to their small righting moment.

The stability of small vessels being seldom investigated, it follows that the dimensions or relative proportions of depth to breadth of new designs must be based on those of vessels which are in service, and it will be seen from examples Nos. 1 and 2 that this method may lead to serious error if due regard is not given to the qualities of design which govern the stability, such as obtaining the greatest possible breadth and area of load water line as is compatible with speed, etc., as the form of the ship in the vicinity of the load line has great influence on the stability.

The rise of floor affects the position of the centre of buoyancy, and with this the height of the metacentre is raised or lowered; the finer co-efficient of displacement, or smaller displacement, on the same dimensions favours the height of the metacentre.

The dimensions of Nos. 1 and 2, as already stated, are similar to those of the larger class of trawlers, but it must be borne in mind that these have 40 to 50 tons of permanent ballast between the floors, which adds considerably to the metacentric height of this class in all conditions.

The different features of design, *i.e.*, double bottom, raised quarter deck, and forecastle, all have an adverse effect on the stability in raising the position of the centre of gravity loaded.

Experience of the behaviour of vessels with known metacentric heights can be the only guide in assigning these minimum heights, and the writer trusts that his paper may lead to a useful discussion on this somewhat obscure subject.

DISCUSSION.

The PRESIDENT—We have had the following letter from Mr. Archibald Hogg, which will be entered on the minutes:—

72, WELBECK ROAD, WALKER,
22nd January, 1903.

DEAR MR. DUCKITT,

Re Mr. Pescod's paper, perhaps the following remarks may be of some use:—

Regarding the small coaster I can scarcely believe that it would behave in such an unsteady manner as it did if it had 9 inches G.M. The chances are that it did not have near as much and that a mistake has arisen in the calculation of gravity centre of the equipped vessel. This vessel has her machinery right aft and consequently would trim all by the stern when the inclining experiment was made. For this excessive trim a complete independent set of calculations of displacement and all centres is required, as the ordinary displacement sheet is not correct in such a case. Besides the centre of gravity should be found fore and aft as well as vertical to water plane, so as to locate it correctly, square off the keel for the loaded trim. I would like Mr. Pescod to say if his centres are found by such independent calculations as indicated above.

It seems to be rather difficult to tell whether the ship is stable when she is moored to a quay, as witness the tug "Tiger" at Greenock the other day. I know a vessel that toppled over immediately the ropes were let go; luckily it was in shallow water and she only dropped her side a foot or two and forty to fifty tons cement ballast just put her right. These cases I think happen because it is never suspected that they are unstable. There seems no excuse for a master who proceeds to sea in a ship with no stability. If he does not know her condition it is an easy matter to find it out and adopt means to ensure her stability as required by the Board of Trade Rules.

It seems to be a matter of opinion as to what G.M. a vessel should have. I can instance a 500 ton steam yacht which had a very small G.M., probably three to four inches which sailed in this condition for two seasons, when she changed ownership. The new owner did not like her easy rolling and put twenty-five tons ballast between her floors, giving her about 12 inches G.M., when she had a stiffer and quicker motion.

I have sent this note because I cannot be present at the meeting on Friday.

I am, yours faithfully,

ARCHIBALD HOGG.

Mr. F. H. ALEXANDER, Durham College of Science, Newupon-Tyne, said—I do not want to unduly extend the meeting, as it is so late, but I should like to make a few remarks on

the paper. In the first paragraph, the writer says that the paper may be of interest to us notwithstanding the fact that few firms in this district build vessels of these types; but I think that is a very good reason why we should have a paper on the subject, because those who seldom build such ships are less likely to have data about them than firms who have built many.

In reference to the curves of stability given in Fig. 3, it would perhaps be an improvement if the numbering of the curves were altered to correspond with the numbers of the ships they refer to; thus curve No. 2, being a second curve belonging to No. 1 ship might be called No. 1a; and curves Nos. 3 and 4 might be Nos. 2 and 2a, as they both refer to No. 2 ship; and so on. It would also add greatly to the value of the paper, if a small outline sectional elevation of each of the ships, Nos. 1, 2 and 3, were given, so that we might have some idea of the extent of the erections and of double bottom, as well as of the position of the machinery; this would make the stability curves given of greater value for purposes of reference.

The chief interest will doubtless centre on vessel No. 1, and there are several points that are worthy of remark. In the first place the G.M. of 9 inches is stated to have been obtained as the result of calculations made after the vessel was inclined to ascertain the position of her centre of gravity. Now it is possible that, owing to the machinery being aft, she had a considerable trim by the stern at the time of the inclining experiment. In such a case, it is always advisable to correct the displacement and the positions of the centre of buoyancy and the metacentre, in order to obtain the true position of the centre of gravity. The correction may be made by working out the necessary values in detail at the noted trim, or, with a sufficient degree of accuracy, by a method which, I fear, there is not time to explain this evening. I find, however, that if the metacentric diagram were used, and the correction for trim neglected, an error of 2 to 2½ inches might result in a vessel of this size in the light condition; and in the load condition an error of 1 to 1¼ inches might therefore result, and the G.M. be reduced by that amount. I do not suggest that Mr. Pescod has failed to deal correctly with this point, because, even if we assume that the vessel left port with a G.M. of 9 inches, I think it is possible to account for her behaviour without making assumptions

beyond those suggested in the paper. We are told that there was about 2 tons of water in the well, and possibly the "water in the ballast tanks due to leaky valves" might soon accumulate to another 2 tons, although the tanks might be reported dry at starting. There was also a strong wind blowing. Now, owing to the flat form of the floor, which rises at a slope of about 3 degrees, the water in the well would be able to run out towards the lee bilges and to collect there, and indeed at 5 degrees inclination a large part of it would be outside the margin plate and would exercise a heeling moment of about 14 foot-tons. The water in the ballast tanks would assist in similar manner, and if we assume a wind pressure of about 2 pounds per square foot on the exposed surface of the hull, the sum of the heeling moments due to these causes is about 30 foot-tons. But we have further to consider an important feature of this case; we are not told what time elapsed, after leaving port, before the vessel foundered, but we may assume that some bunker coal was consumed, and that on this account the draft would lighten about an inch per day. Referring to the metacentric diagram, we see that the curve of metacentres is ascending at the load draft and that its lowest point is at about 8 feet 6 inches draft. Then, unless the consumed coal were taken from a position above the centre of gravity given in Fig. 2, that centre of gravity would not be lowered as the draught lightened, and after some 12 tons of coal had been used the vessel would have her G.M. reduced to 8 inches, with which the righting moment at 5 degrees would be about 32 foot-tons. As this is almost balanced by the sum of the heeling moments already referred to, the steady list of 5 degrees is easy to understand. Water shipped into the well, while the vessel was in this condition, would rush across the deck and make impact with the lee rail, causing the vessel to heel over with a lurch such as the writer describes.

Even if these assumptions are not strictly correct for the particular vessel, No. 1, they are not unreasonable assumptions in themselves, and might easily apply to a vessel of similar dimensions and type, so that it would be possible for such a vessel to leave port with a G.M. of 9 inches and yet to founder as this one did.

We are then justified in deducing from this case the following considerations:—

(1) 9 inches is not enough G.M. for a vessel of this size with such a flat floor, a cellular double bottom, and a thwartship well from which the water can run into the bilges at a small angle of heel; but it might possibly be enough for a vessel with a good rise of floor similar to that of No. 2.

(2) As the writer himself suggests, seeing that the weight of water likely to be shipped on deck by a small vessel is a greater percentage of her displacement than that likely to be shipped by a larger vessel, it is desirable that extra stiffness should be given to meet this contingency.

(3) If the curve of metacentres reaches its lowest point at a lighter draft than the load draft, might it not be advisable to fix the highest allowable position of the centre of gravity at a reasonable distance below this lowest point, rather than to give the same G.M. at the load draft.

With regard to No. 1 ship it might be questioned whether the weight involved in fitting a double bottom would not have been better made use of in giving greater beam combined with a greater rise of floor.

There is just one other matter in which I think the writer enters on debatable ground. At 36 degrees inclination, the sea obtained entry to the machinery compartment and caused the loss of the vessel. We are, however, given a curve of stability carried beyond this angle, calculated in a manner described as the correct way. It might be argued that the stability curve ought to drop abruptly at the 36 degrees, and that its extension beyond that angle should at least exclude the whole of the machinery compartment.

It is desirable, from a scientific point of view, that there should be some standard of uniformity as to the nature of erections which are included in the calculation of stability curves, as practice varies in this respect.

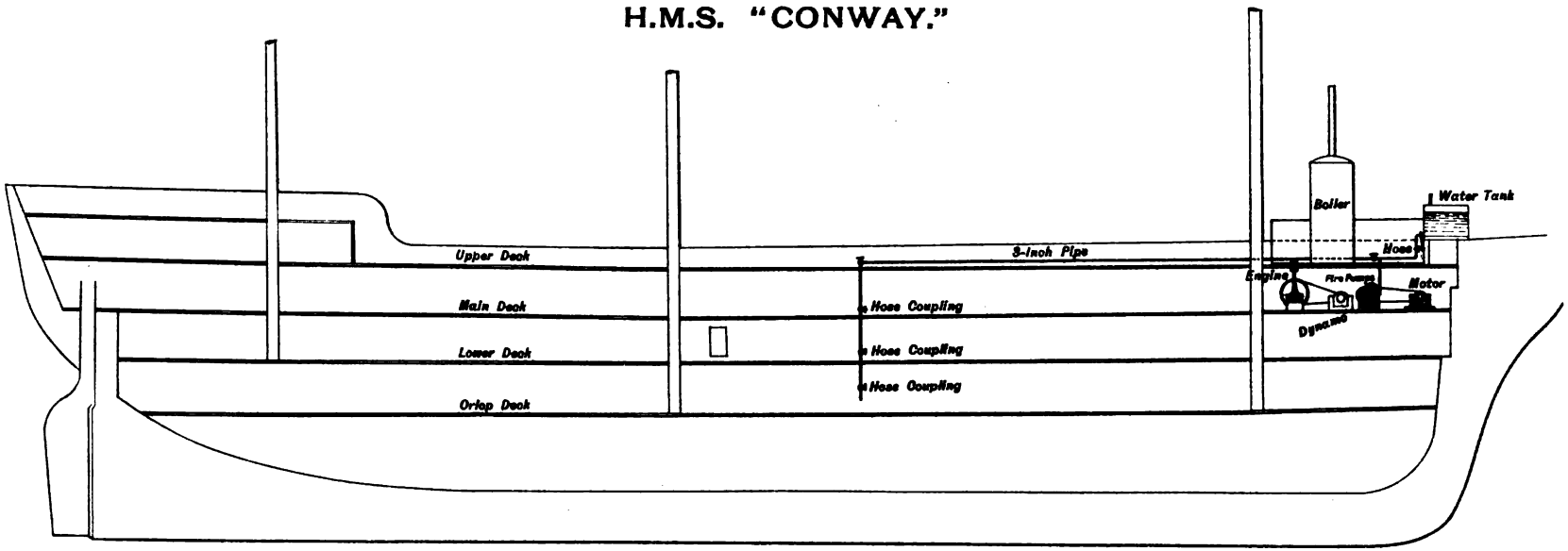
We shall no doubt agree that the writer has done a good service in calling attention to the need of care in the small things connected with the stability of these small vessels.

The PRESIDENT said—Before separating I should like to say how pleased we all are to have Mr. Alexander with us to-night. Mr. Alexander has recently been appointed Lecturer in Naval Architecture in the Durham College of Science in

Newcastle-upon-Tyne. We welcome him in that capacity and as a new member of the Institution, and hope he will often favour us with his presence at our meetings and especially when the more scientific questions connected with naval architecture are under discussion.

The discussion was adjourned, and the meeting dissolved.

To illustrate Mr. J. Denholm Young's Communication on Mr. J.H. Heck's Paper on "Fire extinguishing Apparatus for Ships."



And.r Reid & Compy L.td Newcastle on Tyne.

G 10.A.

PPLICATION OF

TO EXISTING VALVE BOX.

' VALVE-BOX IS SLIGHTLY REDUCED

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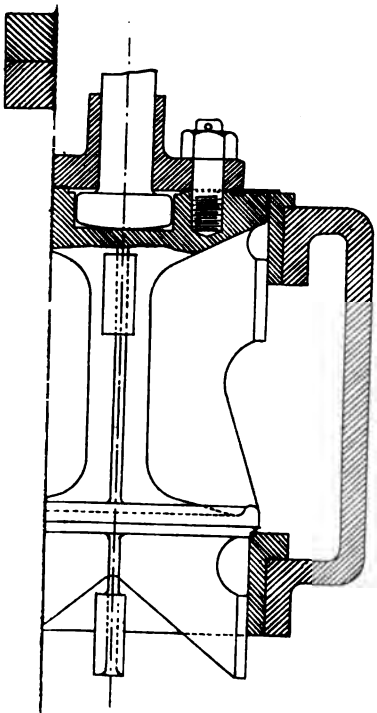


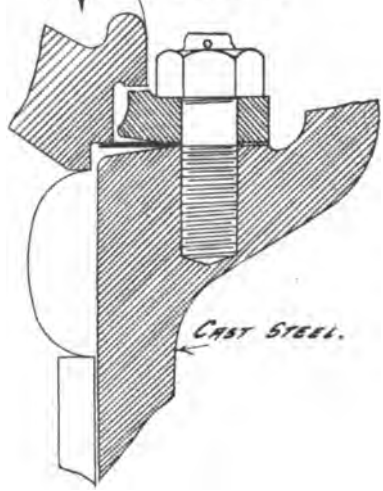
And^w Reid & Comp^y L^td Newcastle on Tyne.

To illustrate Mr. J. Denholm Young's Communication on Mr. J. H. Heck's Paper.

STORAGE BATTERIES H.M.S. "CONWAY."

DISC TYPE SHOWING APPLICATION SHEET METAL OF FLEXIBLE SEAT TO ELASTICITY TO EXISTING VALVE BOXES.

FIG. 19.



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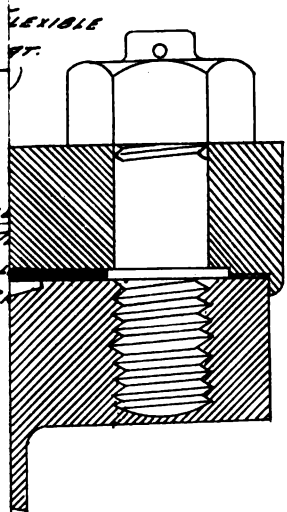
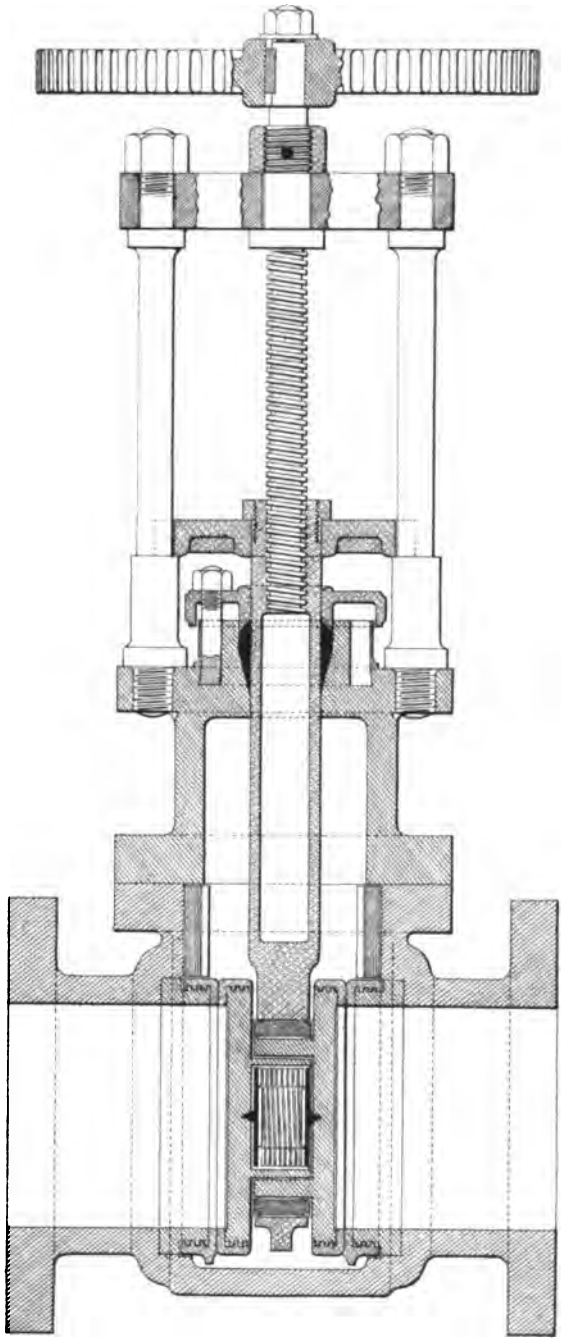


FINA...
PLAIN FLAT C...
FROM HARD RO...
MANGANESE B...

And.w Reid & Compy.d Newcastle on Tyne.

To illustrate M^r H.L. Riseley's Remarks on M^r Hamilton Gibson's Paper on "Large Stop Valves for High Pressure Steam."



And^w Rend & Comp^y L^td Newcastle

NTRIC DIAGRAMS.

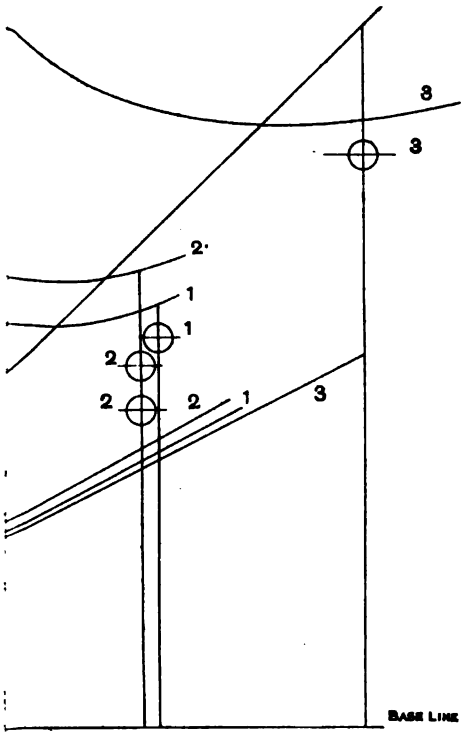
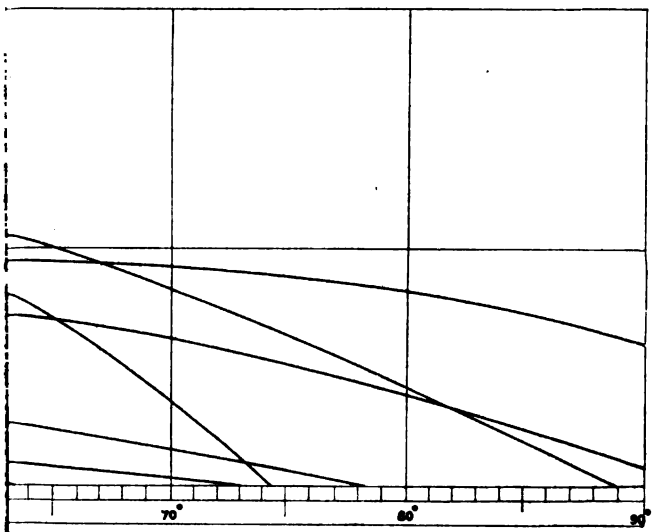


FIG. 2.



And.ʳ Reid & Compʸ Lᵗᵈ Newcastle on Tyne.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.

NINETEENTH SESSION, 1902–1903.

PROCEEDINGS.

THE FIFTH GENERAL MEETING OF THE SESSION WAS HELD IN THE LECTURE THEATRE OF THE TECHNICAL COLLEGE, HART ROAD, WEST HARTLEPOOL, ON SATURDAY, FEBRUARY 21ST, 1903.

HENRY WITHY, ESQ., J.P., PAST-PRESIDENT, IN THE CHAIR.

The SECRETARY read the minutes of the previous meeting held in Newcastle-upon-Tyne on January 23rd, 1903, which were confirmed by the members present and signed by the Chairman.

The CHAIRMAN appointed Mr. J. R. Fothergill and Mr. R. Hirst to examine the voting papers for new members, and the following gentlemen were declared elected:—

MEMBERS.

Cameron, Hugh Robert, Engineer, 1, York Terrace, North Shields.

Collins, Edward D., Engineer, 5, Albert Terrace, Whitley Bay, Northumberland.

Graham, Joseph S., Shipbuilder, Syon Street, Tynemouth.

Hogg, Thomas, Engineer, 8, Lovaine Terrace, North Shields.

Kapadia, Framjee Dorabjee, Engineer, c/o Messrs. The Ahmedabad Ginning & Manufacturing Co., Ahmedabad, British India.

McLellan, William, Consulting Engineer, Collingwood Buildings, Newcastle-upon-Tyne.

Merz, Charles H., Consulting Engineer, Collingwood Buildings, Newcastle-upon-Tyne.

ASSOCIATE.

Elder, George H., Shipowner, Cail's Buildings, Quayside, Newcastle-upon-Tyne

GRADUATE.

Little, John, Engineer Apprentice, High Street, Felling-on-Tyne.

The discussion on Mr. J. Hamilton Gibson's paper on "Large Stop Valves for High-pressure steam" was resumed.

The discussion on Mr. J. H. Pescod's paper on "Minimum Metacentric Heights in Small Vessels" was resumed.

Mr. J. DENHOLM YOUNG read a paper on "Loss of Power in Steamship Vibrations."

RESUMED DISCUSSION ON MR. J. HAMILTON GIBSON'S PAPER ON "LARGE STOP VALVES FOR HIGH-PRESSURE STEAM."

The discussion on Mr. J. H. Gibson's paper on "Large Stop Valves for High-pressure Steam" was resumed.

Mr. THOMAS BURT, Glasgow (a visitor, by permission of the Chairman), said—I do not know that I have anything very particular to say upon the subject, but I happened to be in the district, and I thought I should like to attend this meeting.

Stop valves are usually considered a simple detail in connection with engines, and engineers very often overlook their importance. They think it is an easy thing to make a stop valve, and consequently the detail is overlooked. But these details sometimes give a very great deal of trouble, and I think Mr. Gibson, in his paper, has clearly demonstrated that, at all events, the ordinary type of equilibrium stop valve, or double-beat valve, is not perfect, and has proved the futility of rigid valves to meet the case.

Various expedients have been tried, as for instance, when the body of the chest is composed of a different metal from the valves, by putting in a distance piece between the two valves of exactly the same material as the chest.

In Glasgow we have had considerable experience in valves, and have tried grinding the valve when it is hot, and at other times when it is cold, and afterwards taking a very little off the bottom valve, making the distance between the two valve faces a little shorter than the seats, and when the heat comes on the valves become tight. These are very haphazard ways of getting the valves tight and can only be successful temporarily, because the conditions vary so much. Sometimes the test is all right in the shop, but it is impossible to know what conditions the valve may be put to when it comes into actual practice.

I think Mr. Gibson has put himself to a great deal of trouble in bringing this matter before the Institution, and has done great service in this particular case. The valve he has introduced to your notice has been very successful so far as my experience goes.

I notice Mr. MacColl, of Belfast, sends a drawing of Hornblower's valve; this type was used to my knowledge about 1873, but not very successfully. They were perfectly tight under certain conditions, but under other conditions they were not tight, and consequently there was a great deal of trouble on trial trips, etc.

I have to thank you for the opportunity of speaking at this meeting.

Mr. JAMES WILSON said—I may mention that some years ago I had some experience with a valve fitted to naval engines that gave considerable trouble. In vessels of that class the factors of safety are very low, and they spring very considerably when put into place. Although the valve might be tight when tested in the works it was not tight when fitted on board the ship. Only one way was found of getting over that difficulty. When the seat was put into the valve chest there was no mitre put on it at all, but the mitre on the valve was faced with emery and ground into position, and I may say that that was the only cure they found with the double-beat valve when fitted in position.

The discussion was closed, and the Chairman intimated that Mr. Gibson would reply at the next meeting.

RESUMED DISCUSSION ON MR. J. H. PESCOD'S PAPER ON "MINIMUM METACENTRIC HEIGHTS IN SMALL VESSELS."

The discussion on Mr. J. H. Pescod's paper on "Minimum Metacentric Heights in Small Vessels" was resumed.

Mr. A. McGlashan said—I have only had an opportunity of reading the paper just before coming to the meeting. I think it is one which we ought to welcome on the *Transactions* of the Institution. It deals with a subject, that of the metacentric heights in small vessels, which is of paramount importance. I do not differ from the writer's conclusions, and, therefore, have nothing to say in the way of controversy. Those who design vessels, both small and large, know that, notwithstanding the great demands made for technical education, and the general idea that it would greatly advance our position as shipbuilders, very little attention is given to the lessons of technical education by some of those who are agents for the sale of steamships and who, when a ship is to be built, readily shift from one set of proportions to another without the least regard to the principles to which this paper draws attention. They never require any conditions of stability, as a rule, to be investigated: the great thing is to get the most deadweight carried on a given draught of water for a given sum of money.

I do not think there is the same danger of vessels being built now with too little metacentric height as there was some years ago. Since it has been recognised that good speed can be got with fairly broad ships the beam of ships has been increased, and that has insured of itself an increased metacentric height, and prevented the danger to which Mr. Pescod has drawn attention. I gather, from reading reports of wreck inquiries, that it would be of advantage if those who sit in judgment on shipowners and captains and others had some approved data as a standard of safe metacentric heights by which to be guided in arriving at their decisions, and it would be of great advantage if an Institution like this could, by the industry of its members in the direction in which Mr. Pescod

has gone, collect sufficient data and form such a standard for the guidance of those who have to adjudicate in these matters, and also to some extent enlighten that portion of the public who are responsible for shipping matters as to what the proper standard of metacentric height is. One thing is certain. However much those who order ships and send them to sea ignore stability, the water which bears the ship soons finds out mistakes, and if a ship is constructed contrary to those principles, which are ever active and never vary, the sea will overturn and overwhelm her. The operation of natural laws on which stability is founded has to be reckoned with by taking proper precautions, which ought to be more in the mind of those who order ships and fix their dimensions. I am personally thankful to Mr. Pescod for his paper.

Mr. H. B. Donaldson said—On reading Mr. Pescod's paper it struck me as being one, as Mr. McGlashan has already said, of paramount importance in the present day. One cannot help being struck by the comparatively vague knowledge of stability displayed by those responsible for the construction and maintenance of ships. For that reason I consider any apology is quite unnecessary on Mr. Pescod's part for the paper he has read, since the more emphasis laid on its importance the more probable is it that the subject will receive wider recognition during the preliminary and more advanced stages of ship construction. Apart from questions of seaworthiness its influence on dimensions, and consequently first cost, is worthy of note. An example will make my meaning clear. On inclining a tramp steamer of usual proportions it was found she had a metacentric height of about 6 feet. In load condition I estimated, pretty fairly I think, that she had a G.M. of 3 feet 6 inches (homogeneous cargo on board). Such an excessive G.M. means unnecessarily large beam. On substituting 2 feet G.M. I worked out a new set of dimensions and found that it would be possible to reduce the beam by about 3 feet 6 inches, the required capacity being made up in length. Since beam is the most expensive dimension, these figures are somewhat expressive of the advantage to be gained in this direction alone by paying due regard to this too frequently neglected subject in merchant shipbuilding. I may say this is not an isolated

case, as I have worked out several examples with similar results. I would like Mr. Pescod to give us the ratio of the centre of gravity to depth moulded, and coefficients of fineness for the vessels mentioned in his paper, as I think it would add to the value of the diagrams he gives.

The CHAIRMAN (Mr. Henry Withy) said—I think Mr. McGlashan's suggestion that we might have collective data about metacentric heights is good. Those who have had extended experience in shipbuilding know perfectly well that years ago there were many ships built that would not stand up without ballast when they were light, especially sailing ships. That was due to nothing else but a lack of metacentric height, as Mr. Donaldson has said; 6 feet light is very good, but the nearer you come to a 12 or 18 inches metacentric height loaded ship the more easy will your ship be at sea. It would be easy to insure always having a foot of metacentric height if you could control the loading of the ship. There has been an idea in the minds of captains and others that they must put the heavy weights at the bottom, which has the result of so lowering the centre of gravity that the ship would roll her masts out, as you might say. Many ships exceedingly uneasy at sea have been made quite easy by putting the heavier cargo in the 'tween decks. If we had a paper giving collective data about metacentric heights it would be of use, and would point out to shipowners the question raised by Mr. Donaldson about the beam of ships. The beam of ships has been increased very largely, and not always with advantage.

The discussion was adjourned until the next meeting.

LOSS OF POWER IN STEAMSHIP VIBRATIONS.

By J. DENHOLM YOUNG, Wh.Sch., Member.

[Read before the Institution in West Hartlepool, on February 21st, 1903.]

The vibrations of steamships and the balancing of engines have been of late years frequently discussed at the meetings of the Institution of Naval Architects and kindred societies, and Mr. Schlick and others may be said to have reduced the problem to an exact science.*

The inconvenience and discomfort of vibration in passenger steamships would be of themselves sufficient reasons for taking up the subject seriously, while the stresses induced in the structure and joints of hull and machinery, often so great as to loosen rivets and bolts and to cause cracks in steam pipes, would also form ample justification for directing attention to the subject.

The particular side of the question, however, which I propose to introduce in the present paper, is one which does not appear to have attracted much notice in its application to steamships, and at the time of writing I am not aware of any definite attempt to find a general solution to the problem mentioned, namely, the loss of energy or power sustained in producing those vibrations which have formed the subject of so much able investigation. The loss may indeed not be large, but in these days of refined economy in steamship performance one wishes to know, if possible, the amount of every item in the mechanical balance sheet.

Vibrations in general, in the physical universe as constituted, require energy for their production and maintenance.

The æther-vibrations of light, for instance, may be generated

* The present paper was already written before the valuable series of articles, by Rear-Admiral Melville, on "Steamship Vibrations" commenced to appear in *Engineering*.

by the energy of chemical combustion, as in a gas flame, or by the energy of an electric current, and in either case a constant fresh supply of energy or power is requisite to keep up the æthereal vibration. Directly the supply of energy is cut off, the vibrations apparently cease. What becomes of them in a closed room, for example, while the source of energy is being maintained and immediately after it is cut off, would make an interesting subject for investigation, which would be out of place in this paper. But that the energy of light can be directly converted into work is clearly shown in the well-known instrument known as the radiometer, invented by Sir Wm. Crookes, in which the rotation of vanes is produced by the direct action of light impinging upon them.

The foregoing illustration is only given to show how a phenomenon involving dynamical effects necessarily involves a consumption of energy or power.

The case is equally well illustrated when we look at the realm of sound. The vibrations of a bell or a tuning fork, for instance, die away more or less slowly according to the amount of vibratory energy that can be transmitted to the metal by a single blow, and more or less quickly according to the rate at which that energy is partly transformed into sonorous vibrations of the air, and partly dissipated in raising the temperature of the metal. In starting these vibrations a certain amount of energy is applied and transformed, and to maintain them a continued expenditure of energy is necessary, entirely apart from any mechanical friction of apparatus.

As an example of the continuous conversion of energy or power into sonorous vibrations, consider a pipe organ. The actual energy present in the vibration of the air enclosed in an organ pipe can be calculated from the usual formulæ connecting the size of the pipe with the density and elasticity of the air and the resulting number of vibrations per second. The amount of power required to maintain the sound depends upon various circumstances which need not be discussed in this paper, but which have been determined for all ordinary sizes of pipes by experiment.

By the courtesy of Mr. J. F. Shepherdson, of Liverpool, I was enabled to observe the power consumed in producing the sound given by 240 pipes, ranging from 16 feet to 2 feet,

opened simultaneously. The bellows was driven by a gas engine which, while these pipes were being sounded, indicated about 1 horsepower. The actual horsepower at the pipes, according to Töpfer's tables, would be about 0·3, which shows that a great proportion of the power must be used up in simply driving the apparatus, and forcing the air through the conducting pipes. These considerations, however, do not concern us at present. What it is desired to point out is that a definite amount of power is required for the production and maintenance of sonorous vibrations of any kind, that power being used and dissipated in a number of different ways.

The heavy pulsations often felt in the stokehold and engine-room under certain conditions of funnel draught form a kindred case, the funnel itself acting as a huge organ pipe, and under the influence of the huge pulsations that take place causing the smokebox, the casings, the steam pipes, etc., to vibrate in a manner which is often more distressing than any vibrations caused by the engines.

The local vibration caused by the working of steam winches is another example of what can be done in this way, especially in cases where the deck is not sufficiently supported by stanchions beneath.

A similar case may be mentioned, of a vessel in which the electric lighting engine is placed just below the fo'castle, on the extreme forward end of the main deck. The engine is a single cylinder one and works smoothly up to above its usual revolutions, if properly governed. When more heavily pressed, however, than it is intended to be, the engine thumps considerably and the vibrations are felt at both ends of the vessel.

This effect evidently takes place when the number of revolutions corresponds with the natural vibratory period of the ship, but it is not felt at these same revolutions when the engine is slightly throttled, so that it is most probably due to an "unbalanced remainder" in the inertia of the piston, etc.

And now, if we ask what becomes of all this energy that is given forth, the answer must undoubtedly be that, with the exception of that portion of it which actually goes to wearing out material, almost all the power put into any sort of physical vibration is finally, through the internal viscosity of solids, liquids, and gases, dissipated in form of heat.

We therefore see that unless power is continually applied to maintain vibrations these vibrations will be more or less quickly extinguished according to the circumstances of the case.

Evidently the more perfectly elastic the vibrating body is, the longer will the vibrations tend to continue, while the greater its viscosity or internal friction, the sooner will its vibrations be damped.

Also, when considering the damping effect of an external medium in which the vibrating body is immersed, it is evident that the greater the density of this medium, the more rapidly will energy be expended in producing oscillations, and increase in viscosity of the surrounding medium will also increase the effort necessary to continue vibrations.

Hence we would expect the vibrations of an elastic body to be extinguished much more quickly in water than in air, sea water being almost exactly 800 times heavier than air at the sea level.

The above is borne out by facts, as the accompanying diagram shows, the one instance showing the vibrations of a spring in air, the other, the vibrations of the same spring starting from the same amplitude, in water. It is also evident that it would require a greater continuous effort to maintain such vibrations in water than it would in air. Not only is a greater amount of energy required to produce wave motion or oscillation in a body of water than in the same bulk of air, but also the coefficient of viscosity of water, slight as it is at ordinary temperatures, is stated to be about 15,000 times greater than the viscosity of air. The co-efficient of viscosity of water at 20° C. is ·01, while that of air is only ·000000685.

Further, when treating of the vibration of steamships, we have to remember that energy thrown off in forming surface waves and ripples is not restored to the ship.

The photographs published by Mr. Yarrow* of a torpedo-boat vibrating in still water show the nature of these surface ripples, which, of course, take power for their production. That horizontal or torsional vibrations should throw off such waves is self-evident, and if we consider the case of a steamer at rest, suddenly subjected to a downward impulse of a quarter of an inch, for example, we see that the effect must be similar. For

* See *Cassier's Magazine*, Marine Number.

the body of water that lies to the depth of a quarter of an inch adjacent to the ship's bottom, being unable to escape downwards, is forced to escape outwards and upwards, forming a slight upheaval of water around the sides of the vessel, which upheaval rolls away in the form of a wave. A portion of the energy of this wave may be restored to the vessel on the upward movement of the vibration, but so much of it as rolls away in waves or ripples is lost.

By experimenting with a sectional model in a thin glass tank like a large lantern-slide, the writer found that such waves and ripples were thrown off sideways when the section was vibrating vertically in the water. In addition, a vortex motion was developed beneath the surface of the water, which would not be possible if the vessel were going ahead and acting upon new bodies of water at every instant, or at least only possible to a very slight extent.

In addition to the viscosity, and wave-making, and frictional resistance of the water, all tending to damp the vibrations of the steamship, there are resistances to be overcome within the vessel.

If light, or not a cargo ship, these will be chiefly in the structure, and no doubt the better put together a vessel is, and the firmer her joints, the more nearly will her elasticity approach that of a steel spring. Wood decks and wood fittings, however, all tend to increase the rapidity with which vibrations are damped, and when it comes to taking cargo, we often find that a vessel which vibrates badly when light will vibrate very little or hardly perceptibly when loaded. It does not follow, however, as will be shown hereafter, that there is necessarily less power lost on the small vibrations than on the larger ones. It may very possibly take more power to produce an eighth of an inch vibration in a vessel, when laden with coals or grain, than to produce double that vibration when in ballast, because one of the physical properties of such a cargo might be likened to an intensified viscosity. The writer, however, has not yet had opportunities of comparing the damping effects of different cargoes.

The question now naturally arises, How is the effort to be estimated that is required to continue these vibrations steadily, in cases when it cannot be directly measured?

Mr. Yarrow, I believe, caused a torpedo boat to vibrate by a man leaping regularly on the deck. The amount of vibration due to this exertion of power could be measured and useful deductions gained therefrom. For different types of vessels, however, other methods may require to be used.

Consider the case of the vibrations of a spring, shown in the diagram (Fig. 1, Plate XVII.), when the actuating force is withdrawn, and the spring allowed to vibrate until its motion is extinguished.

At each vibration the amplitude or "swing" is diminished; and a corresponding amount of energy is subtracted from the spring. We can draw a fair curve through the summit of the diminishing vibrations, and the slope of this curve to the horizontal line (or measure of time) will give at any instant the rate at which amplitude is being lost by the spring. Evidently, since the energy is proportional to the square of the amplitude, the initial rate of decrease of energy is given by the tangent to a parabola which has its vertex at the bottom of this inclined line, and passes through the highest point of the damping curve. *If we find, by measurement of the diagram and of the spring, that so many foot-pounds of energy per second were being lost when the curve commenced to droop, then we know that just as many foot-pounds of energy per second are required to prevent the curve from drooping, i.e.,* to maintain the vibrations at a steady height.

The curve shown on Fig. 1 (Plate XVII.) is that of the vibrations of a spring damped under ideal conditions, by internal viscosity only.* This condition is very different from the state of affairs when dealing with steamships.

The curves shown on Fig. 2 (Plate XVII.) are obtained under conditions which more nearly approach the physical conditions under which a ship vibrates. The longer curve in Fig. 2 is damped by the external agencies of the air and the imperfect elasticity of the wood support on which the spring was fixed. The steeper curves are damped by immersion of the spring to varying extents in water, and correspond very closely with the damping curve obtained from the vibrations of a steam vessel in which the engines were easily handled and quickly stopped.

* This curve was shown by Lord Kelvin to follow the "Compound Interest Law."

Other Figs., Nos. 3, 4, 5, 6, show the damping curve of a plank of wood, to which was attached a square box immersed to various degrees in water. It will be seen in these cases how the steepness of the decline varies with the depth of immersion, but that in all these latter cases the curve of decline or damping curve becomes very nearly a straight line.

The same board was experimented with when loaded with cotton, and it appeared in this case that the damping effect of uniform loading with cotton was approximately the same as when an equal weight of water was displaced; *i.e.*, assuming that about half the vibratory energy of the previous experiment was absorbed by the board and half by the water, it would apparently take about 50 per cent. more power to keep the board vibrating when loaded with cotton.

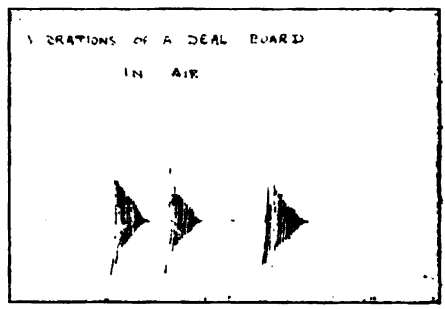


FIG. 3.

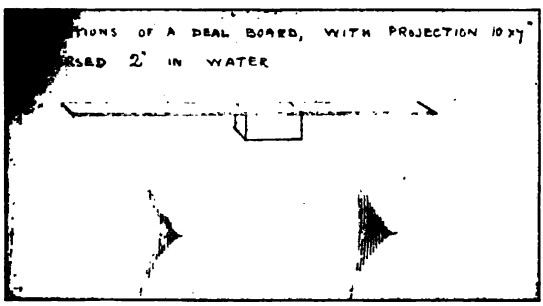


FIG. 4.

One would naturally compare these traces of damped vibrations, with the "curve of extinction" of a ship rolling, of which members will find examples in the *Transactions* of this and kindred societies.

Although it could not be expected that the two curves would assume identically the same form, there must necessarily be a family resemblance between them, as both start with a periodic motion, simple or compound, and both are damped or extinguished by fluid friction and by the resistance of fluid to discontinuous motion.

The vibration extinction curve, however, is affected by another set of forces, viz., the internal viscosity of the vessel's structure, or its lack of perfect elasticity, and also in most cases the still greater lack of elasticity of the vessel's cargo and general fittings, which no doubt absorb a considerable proportion of vibratory energy by their jarring motions, and by their not partaking in the continuity of the vessel's structure—this continuity of structure being an important factor in restoring a portion of the vibratory energy to its source.

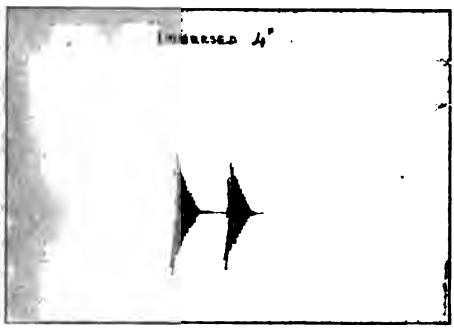


FIG. 5.

Imagine a vessel in dry dock supported only at her nodal points on the keel, with no cargo in her, and vibrating in air under the influence of her machinery. There would be little resistance to vibration save the internal viscosity of the structure. The vibrations might be very severe, but so long as the vessel retained her elasticity, a large proportion of the kinetic energy of the vibrating vessel would be restored at each beat. But fill the dock with water and float the vessel, and we find that although the water may be in a confined space, so that its wavelets and ripples cannot escape, yet the energy they receive from the vessel is not restored to it, being now in a form quite unsuitable for restoration. Add now a coal cargo, and one sees that in a mass so full of "discontinuities" there are so many rubbing surfaces that energy must be very quickly absorbed.*

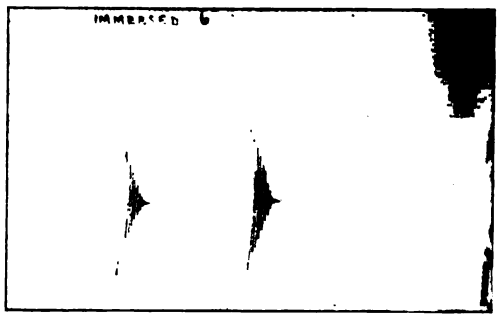


FIG. 6.

A difficulty in the way of applying the above principles to

* Although the vibrations will now be reduced in amplitude.

estimating the horsepower absorbed by steamship vibration at once presents itself, namely, that the engines cannot be suddenly stopped, and thus the true commencement of the damping curve is missing. In the majority of cases, probably, the engines have to be brought up so gradually that an actual damping curve could not possibly be obtained, so that we are left to reason by analogy in this as in so many nautical matters. In the enlargement shown of an actual "pallogram," there is not much difficulty in fairing up the curve to an apex, and estimating very approximately the loss of energy per second from full vibrations (Fig. 7).

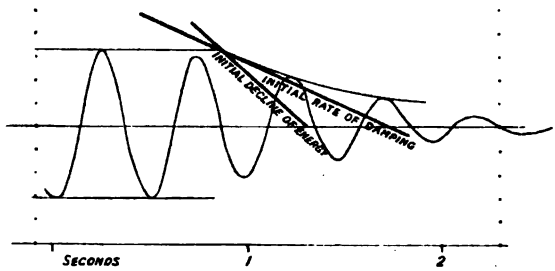


FIG. 7.

Taking a vessel 240 feet long and 2,800 tons displacement, with vibrations 2·1 per second and an eighth of an inch in extent, the loss of energy as indicated by this curve would be about four horsepower (assuming the distance between the nodal points to be about half the length of the vessel).

If vessels of larger displacement, therefore, follow any such law of proportion as we might expect, the actual loss of power is a very small matter indeed, and not worth mentioning in comparison with the discomfort to passengers and stresses of material caused by heavy vibration.

In seeking for a law of proportion, for the purpose of predicting the loss of power in one vessel as compared with another vessel differing in size, one could anticipate that that portion of energy which is absorbed in fluid resistance to vibrations of proportional amplitude will be less in larger ships in proportion to their size than in smaller ones, because the natural vibration period of the larger vessel is lower than that demanded by the "Law of Similarity" of fluid motion. (See Appendix.)

In the foregoing remarks simple vibrations only are dealt

with, compound vibrations evidently requiring to be treated as so many simple vibrations superimposed upon one another, the energy of the whole being equal to the sum of the energy of each part.

It does not follow, of course, that the small vibrations of the higher orders, when superimposed upon the large vibrations of the first order, will have similar damping curves. If they had, these higher vibrations would be damped out altogether and re-started, in many cases, in the course of a single vibration of the first order. This, however, is a consideration which is not likely to affect largely the total estimate of lost power from vibration, although the rapid extinction of small vibrations of higher orders must affect the general analysis of steamship vibrations from other points of view.

The writer has to express his regret that he has not had the leisure to pursue the subject of the paper more thoroughly, but trusts that some member with more time and opportunity may be able to give further enlightment upon it.

APPENDIX.

Assuming that in any vessel the fluid resistance to vibrations of a certain amplitude varies as the square of their frequency, and let—

N = number of vibrations per minute in the larger vessel,

n = " " " smaller vessel,

L = length of larger vessel,

l = length of smaller vessel,

then the relative power required to maintain the vibrations of the larger vessel against fluid resistance as compared with the smaller vessel should be as—

$$\left(\frac{L}{l}\right)^{\frac{7}{2}} \times \frac{N^3}{\left(n\sqrt{\frac{l}{L}}\right)^3}$$

Some interesting points with regard to the damping of vibrations are mathematically dealt with in Prof. Perry's "Calculus for Engineers."

DISCUSSION.

Mr. D. B. Morison said—Mr. Young's paper is an interesting record of careful research on a subject of great importance to naval architects and marine engineers. The three principal results of vibration were: discomfort to passengers, loosening of joints, and loss of power. The latter was not great in amount, but if not reduced to a minimum might lead to very unexpected results.

Some years ago, having experienced some trouble with copper pipes, I adopted as an improvement copper made on a new process. The copper was practically perfect when the pipes were new but vibration and other movements so crystallized the copper that it frequently fractured and had to be replaced. This was an object-lesson on the risk taken by engineers when adopting any development which had not thoroughly stood the test of experience, and was also an example of one of the results of vibration, which was a constant source of annoyance to designers in that it often produced unexpected results.

Mr. J. R. Fothergill (Vice-President) said—I should like personally, and I think I may venture on the part of others, to thank Mr. Denholm Young most deeply, not only for his paper, but for the trouble he has taken in coming from Liverpool to be with us to-night. There is one feature which rather strikes one as being different from what most of us have thought, and that is the very little power used in producing these vibrations. Probably there are no two steamers which vibrate alike, as the conditions producing vibration vary considerably. If you stand on the deck of a large steamer, and realise the mass of matter in vibration, it forcibly strikes one that you use a much larger proportion of power than one quite gathers from Mr. Young's paper, although I am in no position to criticize in any other light than what appeals to one's feelings. I principally rise to express our deep thanks to Mr. Denholm Young for the most interesting paper he has produced. If one had more time to study it there are features which I have no doubt will appeal to many members who at the next meeting may enter into the discussion.

The CHAIRMAN (Mr. Henry Withy) said—I think it is only right that I should supplement what Mr. Fothergill has said by saying how much obliged we are to Mr. Young for reading this paper. The amount of research it shows is very great indeed. If the power that Mr. Young assumes is taken by producing the vibrations of a ship 240 feet long is correct at 4 horse-power, I suppose we may take it that something like $1\frac{1}{2}$ or 2 per cent. of power is used. It certainly strikes me as rather small. The paper generally speaks only of ships in smooth water. I take it that a good deal of the vibration of steamers at sea is due to their being struck by seas. Of course, it is quite impossible to measure the power expended by the sea in striking ships, but there is no doubt it is very large indeed. I hope when members have taken this paper home and read it carefully they will be able by next meeting to give us a very interesting discussion.

The meeting then dissolved.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.

NINETEENTH SESSION, 1902-1903.

PROCEEDINGS.

THE SIXTH GENERAL MEETING OF THE SESSION WAS HELD IN THE MARINE SCHOOL, OCEAN ROAD, SOUTH SHIELDS, ON FRIDAY EVENING, MARCH 20TH, 1903.

JOHN TWEEDY, ESQ., J.P., PRESIDENT, IN THE CHAIR.

The SECRETARY read the minutes of the previous meeting, held in the Lecture Theatre of the Technical College, Hart Road, West Hartlepool, on Saturday evening, February 21st, 1903, which were confirmed by the members present and signed by the President.

The PRESIDENT appointed Mr. James Stewart and Mr. Thomas Shaw to examine the voting papers for new members, and the following gentlemen were declared elected:—

MEMBER.

Floyd, Joseph, jun., Iron and Steel Manufacturer, 18, Telford Street, Bensham, Gateshead.

GRADUATES.

Backhouse, A. E., Electrical Engineer, 58, Fern Avenue, Newcastle-upon-Tyne.

Batty, George L., Electrical Engineer, 95, Gloucester Street, Newcastle-upon-Tyne.

Brown, George M., Electrical Engineer, 21. Westmoreland Road, Newcastle-upon-Tyne.

Burnup, Edward C., Electrical Engineer, 2, Wentworth Place, Newcastle-upon-Tyne.

Davis, Thomas, Electrical Engineer, 4, West Parade, Newcastle-upon-Tyne.
Fowler, A. J. D., Electrical Engineer, 8, East Parade, Newcastle-upon-Tyne.
Gibbon, John R., Electrical Engineer, 59, Maple Street, Newcastle-upon-Tyne.
Hall, George, Electrical Engineer, 7, Wellington Terrace, South Shields.
Jones, Edward, Electrical Engineer, 59, Maple Street, Newcastle-upon-Tyne.
Kirk, Malcolm, Electrical Engineer, 87, Gloucester Street, Newcastle-upon-Tyne.
Leitch, John Shearer, Ship Draughtsman, 89, Wharncliffe Street, Newcastle-upon-Tyne.
McRae, Alexander, Ship Draughtsman, 20, Norfolk Road, Byker, Newcastle-upon-Tyne.
McWilliams, Edwin J., Electrical Engineer, 10, Belgrave Terrace, Newcastle-upon-Tyne.
Nash, Osborn B., Electrical Engineer, 18, Wentworth Place, Newcastle-upon-Tyne.
Purvis, William B., Electrical Engineer, 25, William Street, North Shields.
Thompson, John, Electrical Engineer, 43, Mayfair Road, West Jesmond, Newcastle-upon-Tyne.
Wilson, James Dare, Electrical Engineer, Rose Cottage, Shotley Bridge, Co. Durham.

The SECRETARY read Mr. J. Hamilton Gibson's reply to the discussion on his paper on "Large Stop Valves for High-pressure Steam."

Mr. J. H. PESCOD replied to the Discussion on his paper on "Minimum Metacentric Heights in Small Vessels."

The discussion on Mr. Denholm Young's paper on "Loss of Power in Steamship Vibrations" was resumed and adjourned.

Mr. J. H. ALEXANDER read a paper entitled "A Displacement Table for use with the Tchebycheff Formula."

MR. J. HAMILTON GIBSON'S REPLY TO THE DISCUSSION ON HIS PAPER ON "LARGE STOP VALVES FOR HIGH-PRESSURE STEAM."

The SECRETARY read the following communication from Mr. J. Hamilton Gibson, who was not able to be present to reply to the discussion on his paper on "Large Stop Valves for High-pressure Steam":—

BIRKENHEAD, *March 18th*, 1903.

DEAR MR. DUCKITT,

I am obliged to you for the several reports of discussion on my paper. In some cases I notice the speakers have answered each other, so I need not traverse the same ground again.

The double-beat valve shown in Mr. MacColl's sketch is sometimes known as the Cornish drop-valve, and is, as he says, very old; but, of course, it is none the worse on that account. I find in Lineham's text-book the following remark in relation to this valve which is certainly suggestive:—"On account of distortion caused by unequal expansion, the valve should be finally ground on its seat while hot." As Mr. Burt truly remarks—"A very haphazard way of getting valves tight."

As showing the evolution of ideas, it is curious to note that the modern double-beat valve as shown in my Fig. 1 (Plate X.) is almost the exact converse of the Cornish type. If the valve in Fig. 1 is held stationary and the valve-box is moved up and down, we have practically a Cornish double-beat valve.

I am quite ready to believe that in some respects the Cornish valve is superior to the modern type. Being of somewhat weaker design, it will naturally be more flexible. Also, the distance between valve-faces is minimised.

Mr. Atkinson's "corroborative evidence" is most interesting. His suggestion as to the application of the flexible disc to minor stop-valves has already occupied our attention. A little alteration in detail is necessary; but the principle remains the same. Enquiries from auxiliary engine makers indicate that there is a large field for improvement in this direction.

Referring to the President's remarks, I enclose sketch of a proposed method of fitting a flexible disc to the valve he describes

which should improve matters. (See Plate XVIII.) I imagine that with high-pressure steam there will be a tendency to cut the lower valve face opposite the port bars. We have found it necessary to keep ribs and the like remote from the valve faces: otherwise the steam eddies cut deep grooves in them. (See guide-ribs in Fig. 1, Plate X., and Fig. 7, Plate XI.)

Mr. Griffiths is quite correct in imputing to the Admiralty the onus of my paper ever having been written. Although it is sometimes the fashion to decry the Admiralty requirements as unpractical and impracticable, I am sure their demands often set our wits to work, and result in almost unexpected improvements being attained. It is half the battle to have a clear statement of the requirements, and no one will deny the framers of Admiralty specifications the credit of stating exactly what is wanted.

In self-defence I might say that I wilfully ignored the friction on the screw in the case referred to, not wishing to pile on the agony. Certainly, the friction at the threads would amount to a good deal, and would still further increase the diameter of handwheel.

By ignoring the screw I wished to emphasize the startling result of the next experiment—that even if the threads were merely thrust collars, *i.e.*, no pitch at all, the effort required to turn the handwheel is undiminished.

I am very glad that Mr. Geo. Cockburn was persuaded to favour us with some remarks, as I know his experience is both vast and unique. He is one of the few men who have specialised in stop and safety valves of all kinds, and his contribution to the discussion is most valuable. I am glad that such an authority agrees with me that steam stop-valves might reasonably be reduced in size: the point is evidently worth following up.

In reply to Mr. Riseley, the Admiralty must have some good and sufficient reason for inserting the following clause in their machinery specifications:—"Double-seated sluice valves are not to be used for any purpose in connection with the machinery."

Presumably, sliding surfaces of gunmetal, exposed to heat, and which may remain in contact for a considerable time, are in danger of setting fast, either by exudation of the zinc or molecular attraction.

Finally, I am deeply indebted to the Institution for the oppor-

tunity it has afforded me of classifying and recording the loose and miscellaneous information which I have gathered during the past few years on a subject which at first sight appears somewhat trivial, but which, as the discussion has shown, possesses considerable interest, and still offers further scope for our inventive faculties.

Yours faithfully,

J. HAMILTON GIBSON.

The PRESIDENT said—I am sure we are all very much obliged to Mr. Gibson for the trouble he has taken in producing this most useful paper, and before leaving this subject I must give expression to your wishes by asking the Secretary to convey our warmest thanks to him for his work.

The proposal was agreed to with acclamation.

MR. J. H. PESCOD'S REPLY TO THE DISCUSSION ON HIS PAPER ON "MINIMUM METACENTRIC HEIGHTS IN SMALL VESSELS."

The following communication was received from Dr. John Inglis:—

GLASGOW, *March 14th*, 1903.

DEAR MR. DUCKITT,

The steamer designated No. 1 in Mr. Pescod's paper is, I believe, one which foundered near St. John's, on the east coast of Ireland. Following on this catastrophe there was brought one of the most extraordinary actions ever heard in the Court of Session, Edinburgh.

The author describes the weather on the voyage as moderately calm but further on states that the wind was rather strong.

The sea was, no doubt, rough, but not so rough that a good ship's boat could not live in it, as it is on record that the captain took to the boat, followed by all the crew that happened to be on deck at the time; his alacrity in deserting his ship being such that he fell in the sea and was with difficulty rescued.

Those of the engine-room staff who were below soon realised what was going on overboard and followed in the second boat, kicking in the engine-room skylight in the process and leaving the vessel with her engines going, the stokehold entrances open, and the engine-room skylight partly unglazed; and so it came to pass that they all escaped safe to land.

The unfortunate craft staggered about for some forty minutes, I believe, and then foundered in sight of the coast guard, the land being no great distance off.

The owners brought an action against the builders concluding for the whole price of the ship on the ground that she had not sufficient stability for safety at sea, but they utterly failed to prove their case, the learned Judge finding the proximate cause of loss to be loose water in the ballast tanks, and awarding the defenders expenses.

There can hardly be a doubt that a more competent crew could have brought the vessel into port, or at least have beached her where the boats came on shore, and it is surely a monstrous proposition that a builder is to be held responsible for the safety of a ship, built in accordance with plans and specifications embodying the requirements of the owners, certified by Lloyd's registry, loaded by persons for whom he is not responsible and over whom he has no control, sent to sea in circumstances unknown to him and finally left a derelict with unprotected openings near a lee shore.

The pitfalls for the unwary or even the wary shipbuilder are already numerous enough; there is no need of adding to them by creating "standard" values of G.M.

I submit that it is not proved that the coasting vessel designated No. 1 was lost because of insufficient stability, and that the paper brings us no nearer the minimum value for safety of G.M. than we were before.

Yours faithfully,

JOHN INGLIS.

Mr. J. H. PESCOD, in reply to the discussion on his paper on "Minimum Metacentric Heights in Small Vessels," said—Mr. Hogg, in his letter, and Mr. Alexander, in discussing my paper, refer to the fact that in ascertaining the position of the centre of gravity of a ship, by the inclining experiment, it is not correct to use the height of the metacentric above base corresponding to the mean draft for a vessel which trims considerably by the stern, and that it is necessary to prepare a complete independent set of calculations for displacement, centre of buoyancy, etc.

Surely this is well known to those whose practice it is to carry out this branch of drawing office work, the speaker having frequently to make this correction, and in one particular inclining experiment the increase in the height of metacentric amounted to 9 inches. This error, however, did not occur in the inclining experiment calculations which were made for No. 1 example.

Mr. Hogg also states he has experience of a 500 ton steam yacht which probably had about 3 to 4 inches G.M. This I can hardly credit, as such a yacht would exhibit extreme tenderness in the lowering of the boats and general working of the vessel. He further mentions that she was afterwards stiffened by the addition of ballast between the floors.

Yachts of this size will have three or four times the freeboard that a cargo vessel of the same dimensions possesses, and as increasing the freeboard has much more influence on the amount and range of stability than an increase in the G.M., a comparison of the metacentric height of a yacht with that of a cargo vessel is out of the question. The preparation of stability curves is necessary to show the relative stability of each vessel. I have always understood that a minimum G.M. of 18 inches is what is aimed at in yachts of this size.

This will illustrate that we cannot assume the same minimum metacentric height for different types of vessel. Similarly, we would not think of using the same standard for a turret ship as for an ordinary cargo vessel.

In the larger class of shelter-decked cargo vessels loading statements are supplied, which show that they are sometimes worked with no metacentric height.

Mr. Alexander, whilst suggesting that No. 1 example had possibly slightly less than 9 inches G.M., gives us an account of some forces which would retard the vessel in righting itself. With the first item of these he mistakes the sense in which I use the word "well." I was referring to water on well deck, and not to loose water in hold well, as a vessel of this size would not have one fitted. Mr. Alexander is inconsistent with this error, for later on in his remarks he states, "water shipped into this well while the vessel was in this condition would rush across the deck, and make impact with the lee rail, causing her to heel over with a lurch," thus using the word "well" in the sense I intended it to be applied, and quite different from his previous use of it.

I am indebted to Mr. McGlashan and Mr. Donaldson for their remarks, and I thank the members for the kind way they received my paper.

The PRESIDENT—I think we must accord Mr. Pescod a hearty vote of thanks, and as he is present I hope you will do so by acclamation.

The President's proposal was cordially acceded to.

RESUMED DISCUSSION ON MR. J. DENHOLM YOUNG'S PAPER ON "LOSS OF POWER IN STEAMSHIP VIBRATIONS."

Further discussion was invited on Mr. J. Denholm Young's paper on "Loss of Power in Steamship Vibrations."

The SECRETARY said—I had the following communication upon this paper sent to me after the meeting at West Hartlepool. It has been brought before the Council and passed the Reading Committee:—

WEST HARTLEPOOL, *February 25th*, 1903.

DEAR MR. DUCKITT,

This paper, I must confess, has caused Mr. Young a great deal of research, and possibly may be of great value.

I was very pleased to hear Mr. Young say that probably in steamers of larger dimensions than the size he quoted the loss of power through vibration would not be so great.

Now, sir, my opinion of loss of power by vibration does not entirely agree with Mr. Young's paper, Mr. Young's views being scientific and mine practical.

I am speaking from practical experience, which I consider necessary before giving a conclusive decision on valued subjects, and I may say that my experience is in accordance with Mr. D. B. Morison's idea, explained by that gentleman the same evening at West Hartlepool.

Vibration does undoubtedly cause a great deal of injury to pipes, flanges and sundry other items in steamers, and is no doubt often unpleasant in passenger steamers, but I cannot conceive in any way what loss a steamer can sustain by the alleged loss of power by vibration.

I have proved in many instances that in steamers loaded with cargoes such as railway iron, heavy small seeds, or cask goods, the vibration is very much greater than if loaded with cargoes such as light grain in bulk, cotton in bales, or any other bale goods, in which cases the cargoes are, according to their substance, either trimmed or screwed to the fullest extent of the

capacity of the holds, binding the steamer as it were into one solid mass, so that very little, if any, vibration is felt, whereas, in the former cases, the vibration of the steamer causes vibration to cargoes of this description, or as the saying is, "it is always on the move," and by this means I have proved that the speed of a steamer has been increased eight to ten miles per day over the speed of the same steamer in similar weather and circumstances when loaded with one of the latter named cargoes.

I have, therefore, long since concluded that if even there is a small loss of exerted power caused by excessive vibration it is more than counter-balanced by the increased speed of the steamer.

Yours faithfully,

J. J. BAKER.

The discussion on the paper was again adjourned.

A DISPLACEMENT TABLE FOR USE WITH THE TCHEBYCHEFF FORMULA.

By F. H. ALEXANDER, Member.

[Read before the Institution, in South Shields, on March 20th, 1903.]

In a paper read before the Institution of Engineers and Shipbuilders in Scotland, at Glasgow, in December, 1898, Professor J. H. Biles brought to notice a method of calculating the areas of figures with curved boundaries known as the Tchebycheff system. By this system the ordinates are placed at unequal intervals, but in accordance with such mathematical considerations as render it possible to obtain the true mean ordinate of the area by simply taking the arithmetical average of the ordinates, and thereby saving the necessity of affecting them by multipliers such as are needed under Simpson's rules.

In the course of the discussion upon that paper, one of the speakers recommended that the simplest of the Tchebycheff rules should be used in the same manner as it is now usual to use the first or simplest of Simpson's rules: namely, to divide the given area into a sufficient number of pieces, each of which is dealt with by the rule.

It is obvious that any method which enables us to calculate for a given plane:—

(1) The area,
(2) The position of the centre of gravity,
(3) The longitudinal moment of inertia,
(4) The transverse moment of inertia,

may be used for the whole of the calculations usually found in a ship's displacement table.

In the discussion referred to, it was remarked that the unequal spacing of the ordinates would prove a serious disadvantage, in that it would introduce fractional levers for the longitudinal moments, thereby causing so much extra work as to counter-

balance its advantages and render it inadvisable to use the rule for more than the mere finding of an area.

The method to be described in this paper was devised by the writer, and introduced into one of the largest shipyards on the Clyde, and it has been used there for some three years with such satisfactory results as to lead to its adoption as the standard practice of the firm.

It may best be explained by reference to a single waterplane whose area and moments are calculated in the following manner.

Arrangement of Ordinates.

In Fig. 1 (Appendix A, Plate XIX.) let the longitudinal centre line, AM, be divided into ten equal intervals in the points B, C, D, etc. If ordinates be drawn from these points to the curved boundary of the half-plane, the area is divided into ten portions, each of which it is proposed to treat by Tchebycheff's first rule.

Mark off, from each end of each interval, a distance equal to ·2113 of that interval, so that A1 = ·2113 × AB, and B2, B3, are the same distance from B; and so on. The ordinates drawn from 1, 2, are those needed for the area upon the base AB; 3, 4, for that upon the base, BC, and so on.

Area of Waterplane.

Half the sum of the ordinates 1 and 2 is the mean ordinate of the area on AB. The mean ordinate of the whole half-plane is $\frac{\text{sum of ordinates}}{\text{number of ordinates}}$, and this, multiplied by the length (AM), and by 2, gives the area of the whole waterplane.

Centre of Flotation, or Centre of Gravity of Waterplane.

F is the middle of length. In the afterbody (say towards end A), No. 10 ordinate is multiplied by 0, Nos. 9 and 8 by 1, Nos. 7 and 6 by 2, Nos. 5 and 4 by 3, Nos. 3 and 2 by 4, and No. 1 by 5. Similar multipliers are used for similarly placed ordinates in the forebody. The moments so obtained are separately summed in the afterbody and in the forebody, and the difference of these sums, divided by the sum of ordinates, is the distance of the centre of flotation from F, measured in

intervals. To convert the distance to feet it is only necessary to multiply by the length of an interval (AB).

An explanation of the levers here used will be found in Appendix C. The arithmetical work is so simplified in this respect as to constitute a strong recommendation to the system.

Longitudinal Moment of Inertia.

Here the same simplified levers are again used, and, as explained in Appendix C, the sum of the moments is multiplied by the cube of the length of an interval, the product being the moment of inertia of the whole plane, about an axis through F. The usual correction is made to obtain the moment about an axis through the centre of flotation.

Transverse Moment of Inertia.

This is obviously obtained thus:—

$$2 \times \text{length} \times \tfrac{1}{3} \times \frac{\text{sum of cubes of ordinates}}{\text{number of ordinates.}}$$

Advantages.

Comparing these calculations with those carried out in the usual manner we notice:—

(*a*) The multipliers are dispensed with.

(*b*) The levers for moments are simplified. (Note that six of the ordinates do not need multiplying at all, and that four others are only doubled.)

(*c*) Experience seems to show that, with the usual forms of ship curves, actually greater accuracy is obtained by this method than by Simpson's.

(*d*) Subdivided end intervals are unnecessary, possibly because the end ordinates give a better measure of the shape near the ends than the more distant Simpson ordinates.

It may be noted that it is not necessary to draw ordinates at A,B,C,D, etc., but only at 1, 2, 3, 4, etc.; but it is necessary to clearly understand that the ordinates 1 and 2 are used for the section of the plane which stands on the base AB, and so on, and also that the term "interval" means the distance AB.

Vertical Integration by Simpson's Rule.

It is preferred to use Simpson's rule for the vertical integration, because, under that system, each alternate waterplane is the

boundary plane of the displacement volume which must be used as a divisor in calculating the height of the metacentre above the centre of buoyancy. Separate boundary waterplanes might have to be calculated, in addition to those required for displacement, if the vertical work were carried out by the Tchebycheff method. The disadvantage of this extra work would more than counterbalance the small amount involved by the use of Simpson's multipliers. In addition to this there is the advantage of interpolation of intermediate displacements, and other functions, by the 5-8 rule. For the longitudinal integration these arguments do not apply.

Displacement Table.

A specimen displacement table is given in Appendix A (Plate XIX.) shewing an arrangement of the calculation under this system. The operations can be easily followed by a beginner, as each line has its printed direction. The main portion of the vessel is dealt with by means of waterplanes calculated as described, but the lower part is treated as an appendage, whose sectional areas at the designed displacement stations are found by planimeter (or any other suitable method) and set off as ordinates to a curve of areas upon a base of length. Ordinates to this curve are then measured at the Tchebycheff stations and entered in the form provided, and the volume and longitudinal centre of the appendage are obtained by treating these ordinates as were the ordinates of the waterplanes.

For the vertical centre of buoyancy of this lower appendage a modification of the Morrish formula is used, namely:—

$$\text{V.C.B. above top of keel} = \frac{5D + 2M}{6}$$

where D = mean draft of appendage, and M = displacement of appendage in cubic feet divided by area of upper surface of appendage (or No. 1 waterplane) in square feet.

For explanation of this formula see Appendix D.

Some operators prefer to calculate the lower appendage by waterplanes more closely spaced than those of the main portion, and there is no reason why the table should not be arranged to permit of this. The writer, however, after an extended experience of several methods, considers the use of the planimeter the easiest and most accurate method of dealing with this part,

particularly if the formula, just referred to, is used for determining the vertical position of the centre of buoyancy.

Disadvantages.

It would not be just to exclude a reference to such disadvantages as have appeared in using this method:—

(1) As the ordinates are measured from the waterplanes, instead of from the body plan, it is necessary to draw a sufficient number of waterplanes in the half-breadth plan before the calculation can be made.

(2) In taking off the ordinates from the half-breadth plan there is occasionally a difficulty in reading them, especially when the vessel has tumble home below the deepest draught-line. With a little care, however, and if necessary, the checking of one of the midship stations from the ordinates of a station near it on the body plan, this can be overcome.

(3) To obtain the midship area curve, an independent set of ordinates may need to be taken from the body plan.

Accuracy.

As previously referred to, this method has been adopted after considerable testing, by one of the leading shipyards on the Clyde. The tests it was put to included:—

(1) Comparison of results with those obtained by a similar number of Simpson ordinates, for figures whose areas and moments could be calculated by independent processes.

(2) Comparison of results with those obtained by a similar number of Simpson ordinates, for ships' waterplanes of varying degrees of fulness.

(3) Comparison of results similarly obtained for the complete displacement tables of vessels of all classes, ranging from torpedo boat destroyers to the largest and fullest cargo steamers.

A few comparative results are given in Appendix E.

Saving of Time.

This is always a somewhat difficult matter to gauge justly, but it would seem that the time taken in making the complete calculations, by this method, is only from one-third to one-half of that required to obtain the same information by the usual method. This may perhaps appear to be the estimate of a sanguine

supporter rather than actual fact, but it should be remembered that the saving of labour acts doubly, because it not only saves the time needed for the extra operations, but it reduces the tendency to tedium, and encourages the calculator to feel that he is getting through with his work. Experience has shewn that this gives no small gain in promoting accuracy as well.

Number of Ordinates Required.

Tests have been made as to the degree of accuracy obtainable by using 12, 16, and 20 ordinates; and similar tests with 13, 17 and 21 Simpson ordinates. The results showed that whether Tchebycheff or Simpson ordinates were used, the smaller numbers would perhaps be sufficient for ships with fine lines, but for the usual forms of cargo vessels the closer spacing was desirable.

Absence of "Cross-Check."

Some calculators lay stress upon the value of the cross-check in the ordinary calculation, and would doubtless miss provision for it in the appended table. The necessity is less here, however, as a possible source of error is removed with the multipliers. A good cross-check on the accuracy of the addition can best be made by allowing an independent hand to take down the ordinates as they are read off, but to arrange them in 20 columns of seven each. The sum of the sums of these columns should agree with the sum of the sums of the seven columns worked by the calculator in the table. The independent check thus made may easily be carried out by one of the junior hands.

Number of Waterplanes.

The use of seven waterplanes in the main portion is considered quite sufficient, whether this, or Simpson's system, be made use of for their calculation. Four values at least can thus be obtained for all curves, and, for the displacements and the curve of transverse metacentres, seven values can be obtained, if the former are interpolated by the 5-8 rule at waterplanes Nos. 2, 4 and 6.

In conclusion, the writer wishes to express his deep sense of obligation to Mr. W. J. Luke, the naval architect of Messrs. John Brown & Co., Ltd., of Clydebank, for the permission to introduce and test the system in the office of that firm, and for the kind and helpful interest he has taken in its development.

APPENDIX B.

Explanation of Spacing of Ordinates.

In Fig. 2 let ABCDE represent a portion of a waterplane upon one of the intervals. FD is an ordinate midway between AE and BC. GH and KL are parallel to EC and EK is $\frac{2}{3}$ of EG. OQ and PR are parallel to DF and are drawn through M and N where the curve EDC cuts the line KL.

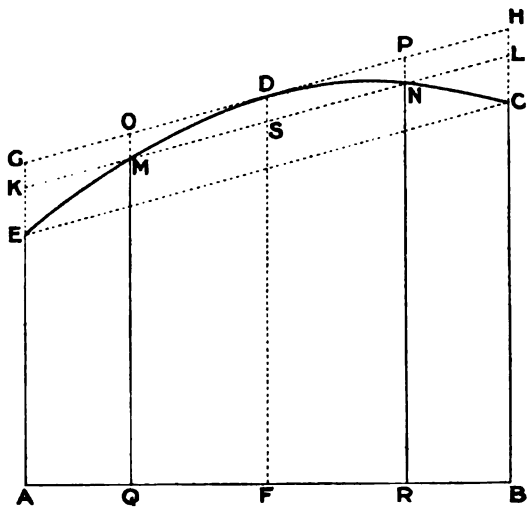


Fig. 2.

Making exactly the same assumptions as would be made in using Simpson's first rule (with the ordinates AE, FD and BC).

Firstly—

$$\text{KECL} = \frac{2}{3}\,\text{ECHG} = \text{ECDE}.$$

$$\therefore \text{ABLK} = \text{ABCDE}.$$

But FS is the mean height of ABLK and therefore of ABCDE. If MQ and NR are equidistant from SF, half their sum will equal SF, and therefore the mean height of ABCDE.

Secondly—

$$\frac{\text{OM}}{\text{GE}} = \frac{1}{3} = \frac{\text{OD}^2}{\text{GD}^2};\ \text{hence}\ \frac{\text{OD}}{\text{GD}} = \sqrt{\frac{1}{3}} = \cdot 5773.$$

Hence $\text{OD} = \cdot 5773 \times \text{GD}$.

$\therefore\ \text{QF} = \cdot 5773 \times \text{AF}$.

$\therefore\ \text{AQ} = \cdot 4227 \times \text{AF} = \cdot 2113 \times \text{AB}$.

Similarly $\text{RB} = \cdot 4227 \times \text{FB} = \cdot 2113 \times \text{AB}$.

Therefore ordinates can be drawn at Q and R whose half sum is the mean ordinate of the area ABCDE.

APPENDIX C.

Explanation of Levers made use of in finding the First and Second Moments.

The levers are measured in intervals and are taken about an axis through the middle of length F. Considering A as the after end (Fig. 1, Plate XIX.) and afterbody levers as positive :—

No. 10 ordinate is 0 + ·2113 intervals aft of F
9 „ „ 1 − ·2113 „ „ „
8 „ „ 1 + ·2113 „ „ „
7 „ „ 2 − ·2113 „ „ „
6 „ „ 2 + ·2113 „ „ „ and so on.
11 „ „ 0 + ·2113 „ forward of F
12 „ „ 1 − ·2113 „ „ „ and so on.

Thus, aft of F, the integer multipliers will be 0, 1, 1, 2, 2, 3, 3, 4, 4, 5, and in addition × ·2113 × each even ordinate and − ·2113 × each odd ordinate.

Forward of F, the integer multipliers will be − 0, − 1, − 1, − 2, and so on, and in addition " + ·2113 × each even ordinate," and " − ·2113 × each odd ordinate" because forebody levers are negative.

Hence, in the earlier stages of using this method, the ordinates were arranged in two columns, so that the odd and even ordinates might be summed separately, and the difference of these sums was multiplied by ·2113 and called the "correction for unequal spacing." This was added to, or subtracted from, the moment function obtained by using the integer levers, according as the sum of the even or the sum of the odd ordinates was the greater.

For the Moment of Inertia or Second Moment it is necessary to employ the squares of the above levers; and as the square of, say,

+ 1 + ·2113 is + 1^2 + $·2113^2$ + 2 × 1 × ·2113
and of − 1 − ·2113 is + 1^2 + $·2113^2$ + 2 × 1 × ·2113
and of + 1 − ·2113 is + 1^2 + $·2113^2$ − 2 × 1 × ·2113
and so on, it is evident that there are three steps, viz. :—

1. Multiply the first moments by the levers 0, 1, 1, 2, 2, etc. ; all products are + sign.
2. Multiply the sum-of-ordinates by $·2113^2$ (= ·045).
3. The first moments being set down in two columns, the difference of the sums of the columns is multiplied by 2 × ·2113 (= ·423). Notice that Nos. 10 and 11 are both + sign.

The sum of the above three items is multiplied by $\frac{\text{Length}}{\text{No. of ordinates}} \times (\text{Interval})^2 \times 2$; or more simply by $(\text{Interval})^3$ and the product is the moment of inertia of the whole plane of about the transverse axis through F. The usual correction must be made to refer the moment to the axis through the centre of flotation.

After some eighteen months' experience, it appeared justifiable to entirely ignore these "corrections for unequal spacing," and the calculations then became simplified to the present form. An example illustrating the inclusion of these corrections is here given.

No.	Ordinates. +	Ordinates. −	Levers.	Moments for C. F. +	Moments for C. F. −	Moments for Inertia.
1		1·2	5		6·0	30·0
2	5·2		4	20·8		83·2
3		7·7	4		30·8	123·2
4	9·9		3	29·7		89·1
5		10·9	3		32·7	98·1
6	11·8		2	23·6		47·2
7		12·2	2		24·4	48·8
8	12·4		1	12·4		12·4
9		12·5	1		12·5	12·5
10	12·5		0			
				86·5	106·4	
11		12·5	0			
12	12·4		1	192·9		
13		12·0	1		12·4	12·4
14	11·3		2	12·0		12·0
15		10·5	2		22·6	45·2
16	9·2		3	21·0		42·0
17		7·8	3		27·6	82·8
18	5·7		4	23·4		70·2
19		3·9	4		22·8	91·2
20	1·0		5	15·6		62·4
					5·0	25·0
Sums	= 91·4	91·2				
				72·0	90·4	987·7
	Sum = 182·6			162·4		

192·9 − 162·4 = 30·5 aft.

Correction (91·4 − 91·2) × ·2113 = ...

Excess Moment aft = 30·5

+ ·045 × 182·6 = + 8·2

+ (158·5 − 196·8) × ·423 = − 16·2

Function for Moment of Inertia about centre of length = 979·7

Assuming the vessel 100 feet long, the longitudinal interval would be 10 feet; area of waterplane, 182·6 × 10 = 1826 square feet; centre of flotation aft centre of length, 30·5 × 10 ÷ 182·6 = 1·67 feet; moment of inertia about centre of length, 979·7 × 10^3 = 979700 square feet × feet.^{2}

APPENDIX D.

Explanation of Formula used for Finding the Vertical Centre of Buoyancy of Appendage.

The axis for vertical measurements in mercantile vessels is usually the base line or top of keel at middle of length.

Morrish's formula published in the *Transactions* of the Institution of Naval Architects for 1892 gives the vertical distance below the waterplane as $\frac{D}{6} + \frac{M}{3}$ where D = mean draft of volume at middle of length, and M = Rankine's mean draft or

$$\frac{\text{volume in cubic feet}}{\text{area of waterplane (sq. ft.)}}.$$

Height above base line will then be $D - \left(\frac{D}{6} + \frac{M}{3}\right)$, and this is equivalent to $\frac{5D - 2M}{6}$.

APPENDIX E.

Comparative Results obtained by Simpson's Rule and by Tchebycheff's as Described in the Paper, no correction being made for the Unequal Spacing of Ordinates in the latter case.

Three waterplanes of the general forms given in Fig. 3 were integrated. The length in each case was 60 feet. 21 Simpson ordinates and 20 Tchebycheff ordinates were used. The results were as follows:—

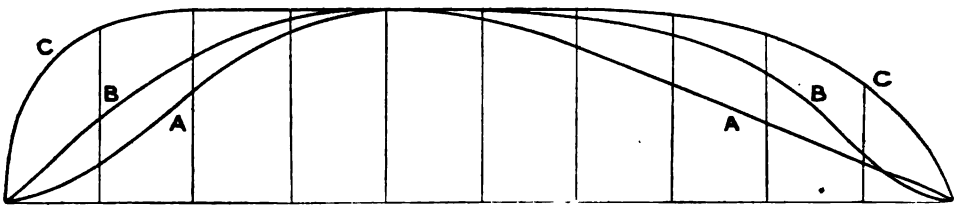


Fig. 3.

	Area. sq. ft.	Centre of Flotation from Mid-length.	Longitudinal moment of Inertia.	Transverse moment of Inertia.
A. Tchebycheff	675·2	1·330	100,200	14,236
Simpson	678·7	1·257	101,204	14,207
B. Tchebycheff	837·5	1·033	148,877	21,136
Simpson	837·0	1·027	147,580	21,100
C. Tchebycheff	1040·1	1·702	249,916	30,348
Simpson	1035·3	1·573	245,528	30,288
Do. with extra ordinates	1038·6	1·658	248,174	30,329

In this last case four additional Simpson ordinates were introduced by the subdivision of the end intervals. It will be observed that the deviation from this last result is less by the Tchebycheff method than by the Simpson method, where the number of intervals correspond.

Taking special figures whose functions may be determined by independent mathematical formulæ, the following cases are of interest:—

(1) A semi-curve of versed sines generated by a circle whose radius is, say, 10 feet and upon a base whose length is $\pi \times 10 = 31{\cdot}416$ feet.
(2) A semi-cycloid generated by the same circle and upon the same base.
(3) No. 1 with parallel body introduced to lengthen the base to 40 feet.
(4) ,, ,, ,, ,, 50 ,,
(5) ,, ,, ,, ,, 60 ,,
(6) No. 2 ,, ,, ,, ,, 40 ,,
(7) ,, ,, ,, ,, ,, 50 ,,
(8) ,, ,, ,, ,, ,, 60 ,,
(9) A quadrant of 20 feet radius.
(10) Do., do. with parallel body introduced to lengthen the base to 60 feet.

The following values were obtained by the use of 11 Simpson ordinates and of 10 Tchebycheff ordinates in each case. The drawings were on a scale of $\frac{1}{4}$ inch = 1 foot, and the ordinates were measured to two places of decimals.

No.	Areas of Half-planes.			C.G. from Wide End.			Transverse Moments of Inertia of Half-planes about Centre Line.		
	Actual.	Simpson.	Tcheby-cheff.	Actual.	Simpson	Tcheby-cheff.	Actual.	Simpson.	Tcheby-cheff.
1	314·16	314·16	314·16	9·34	9·37	9·28	26,180	26,078	25,930
2	471·24	468·27	468·41	12·87	12·81	12·76	45,815	45,390	45,187
3	485·84	484·67	485·00	13·11	13·08	12·98	49,070	48,985	48,965
4	685·84	684·00	685·05	17·83	17·76	17·73	75,736	75,230	75,496
5	885·84	886·00	885·72	22·67	22·69	22·58	102,402	102,304	102,352
6	642·92	635·52	640·56	16·87	16·60	16·72	68,705	67,486	68,167
7	842·92	838·83	839·45	21·68	21·55	21·52	95,371	94,976	94,697
8	1042·92	1038·64	1042·92	26·57	26·44	25·98	122,038	121,803	121,930
9	314·16	314·32	314·27	8·48	8·78	8·46	31,416	31,817	31,506
10	1114·16	1107·20	1116·24	28·03	27·81	27·99	138,082	138,140	138,004

It is to be observed that, although in some of these cases there is shown to be a slight error in the position of the centre of gravity of the semi-curves, the centres of complete water-planes would probably be more correct, because the "moment" errors would tend to neutralise each other, being in opposite directions from mid-length.

DISCUSSION.

Mr. J. H. HECK, in response to an appeal from the President, said—It is a source of congratulation to have such an able gentleman as Mr. Alexander with us to-night. He has not been very long here. He has, however, already set to work and given us this interesting paper in which he explains and illustrates a method devised by him for use with the Tchebycheff method in making ship calculation. It is suggested that the proposed tabular sheet should be filled up and plans added so as to more fully illustrate the working. Mr. Alexander is quite right when he refers to the tedium felt in getting out the calculations usually made for vessels. In the paper it is stated that in fine vessels a fewer number of ordinates can be employed than would be necessary for vessels of full form. This does not accord with my experience; perhaps I have not correctly read the paragraph. In France the trapezoidal rule is universally employed. I have calculated full curves by this rule and found that if extra or half-intervals were taken the results obtained were quite near enough. I have, after reading the paper, constructed some of the curves given in the appendix and determined the results by Simpson's, the trapezoidal, and the method suggested in the paper. When the ordinates were measured by a scale very little difference was found in regard to accuracy and time. This question of time was perhaps due on my part to want of expertness in jotting down and reading off the figures. In conclusion, I think we are all indebted to Mr. Alexander for the suggestions and the work which he has been good enough to put forward in the form of the paper.

Mr. ALEXANDER—Not by way of reply in any way, but in reference to what Mr. Heck has said, I had intended completing that table by filling it in with figures taken from a ship, but time did not permit. I shall now do so, so that when it is published in the *Transactions* it will contain the complete working, so that the operation can be still more easily followed.

The PRESIDENT—I am not quite sure whether Mr. Heck suggests that he and Mr. Alexander at next meeting should

compare the time required. Is that the suggestion? Are you going to have a race with Mr. Alexander?

Mr. HECK—Mr. Alexander would beat me easily so far as time was concerned. I have in all cases employed ten or twenty intervals and this in the proposed revised method led to the measurement and use of more ordinates. Probably a less number of ordinates would have sufficed to get fairly accurate results.

The discussion was adjourned and the meeting dissolved.

To illustrate Mr. J. Denholm Young's Paper on "Loss of Power in Steamship Vibrations."

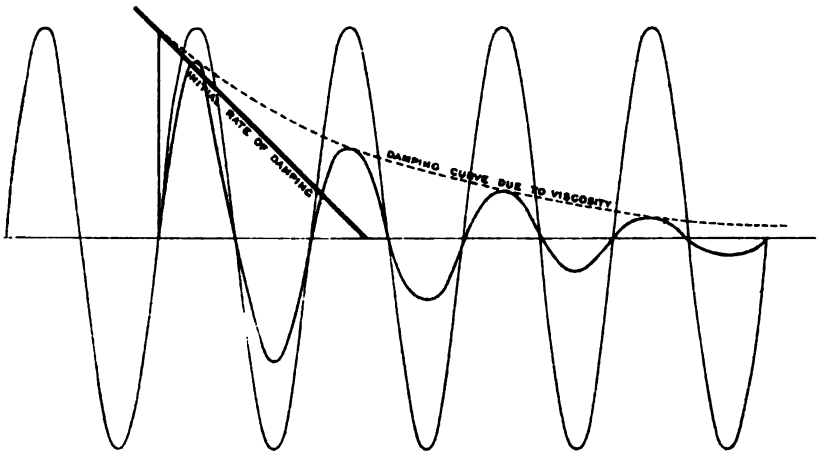


FIG. 1.

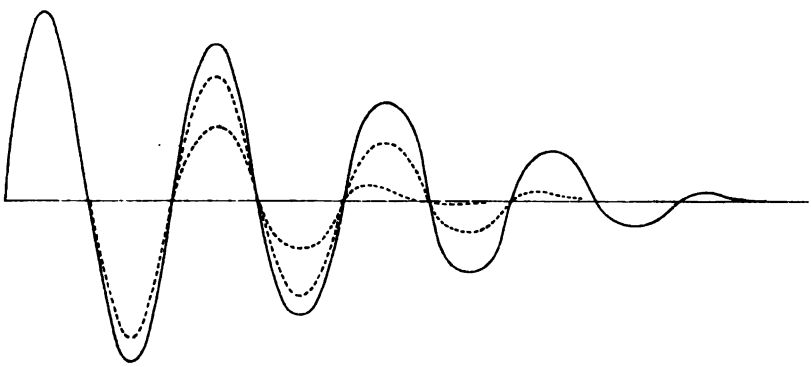
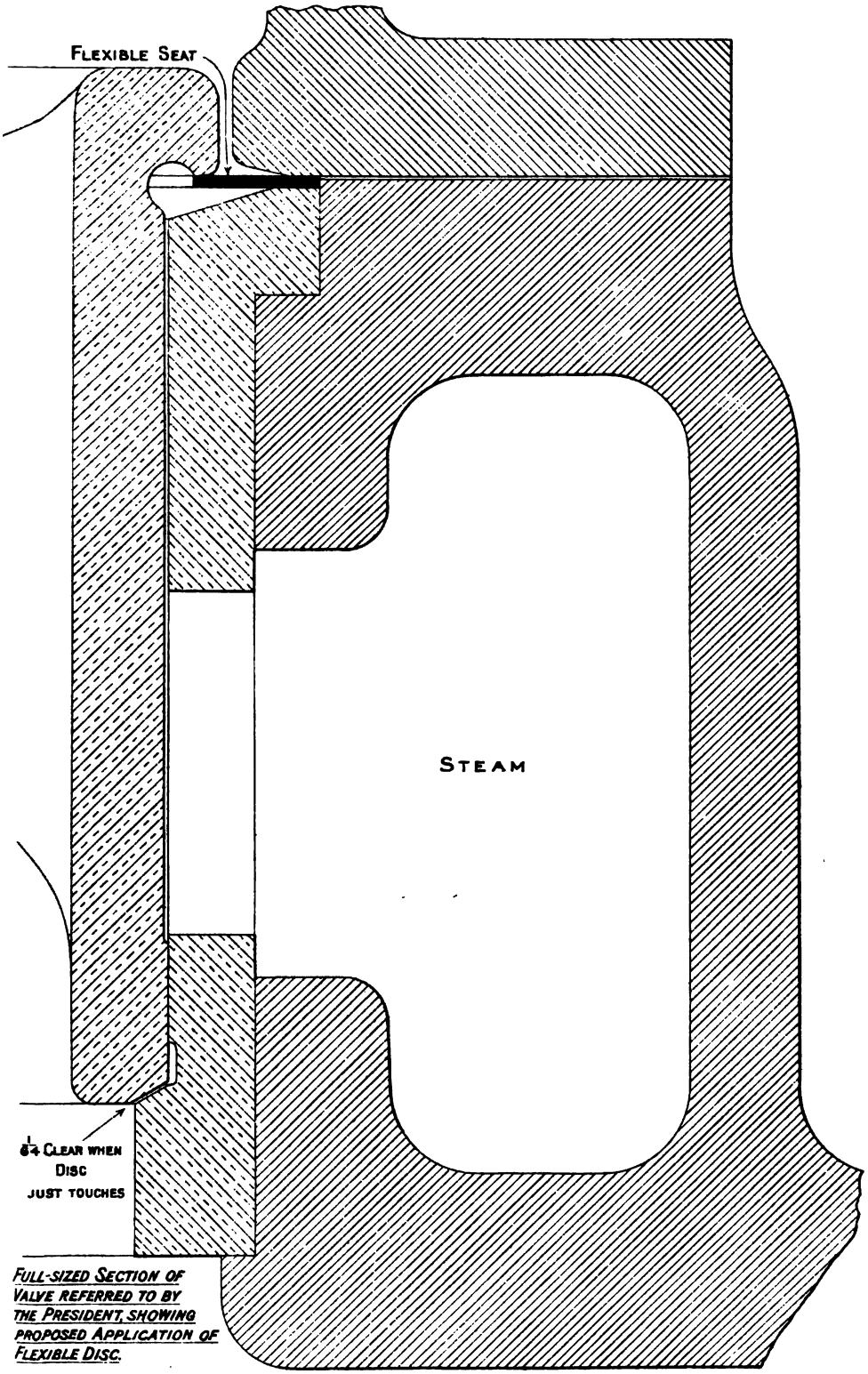


FIG. 2.

And.w Reid & Comp.y L.td Newcastle on Tyne.

To illustrate Mr. J.H. Gibson's Reply to the Discussion on his Paper on "Large Stop-valves for High Pressure Steam."



FULL-SIZED SECTION OF VALVE REFERRED TO BY THE PRESIDENT, SHOWING PROPOSED APPLICATION OF FLEXIBLE DISC.

Proceedings N.E.C.I. of E. & S. 1902-3
Session XIX.

44	METACENTRES ABOVE BASE =		20·82		14·37		11·924		10·931

LONGITUDINAL METACENTRES.

45	Sums OL^2 (Line 1)		526·1		781·8		864·6		987·7
46	Mult. by G : Products	420	8800	585	4400	691	6800	790	1600
47	Deduct Area x $C.B^2$: (Lines 13-18)	1	0355	1	3620	2	4055	4	0740
48	Moments of Inertia	419	8445	584	0780	689	2745	786	0860
49	Divisors : Volume cu. ft. ex. shell		8380		9142	1	5771	2	2904
50	LONGITUDINAL "B.M."		1240		639		437		348

MOMENTS TO CHANGE TRIM ONE INCH.

51	Longitudinal "G.M."*	1247	644	441	346
52	Mult. Displ. Tons ÷ Length Inches	·0408	·1106	·1905	·276

V.C.B. By formula = 1·22 Feet above Base

L.C.B. = $\frac{C \times \text{Diff. Moments}}{S}$

= 2·28 Feet ~~Ford. or~~ Aft C.L.

{ Vertical Centre of Buoyancy of Appendage = $\frac{5D-2M}{6}$ where D = mean draft of appendage and M = displacement of appendage in cubic feet, divided by area of No. 1 Waterplane in square feet.

TOTAL DISPLACEMENTS.

ITEMS.	DISPL. No. 3 W.L.	VERTICAL ABOVE BASE.		LONGITUDINAL ABOUT C.L.		DISPL. No. 5 W.L.	VERTICAL ABOVE BASE.		LONGITUDINAL ABOUT C.L.		DISPL. No. 7 W.L.	VERTICAL ABOVE BASE.		LONGITUDINAL ABOUT C.L.	
	TONS.	V.C.B.	MOMENTS.	L.C.B.	MOMENTS.	TONS.	V.C.B.	MOMENTS.	L.C.B.	MOMENTS.	TONS.	V.C.B.	MOMENTS.	L.C.B.	MOMENTS.
Main Portion	164·6	3·035	499·5	2·018	332·1	354·0	4·095	1449·6	2·225	787·6	557·8	5·159	2877·7	2·475	1380·5
Lower Appendage	96·6	1·22	117·9	2·28	220·2	96·6	1·22	117·9	2·28	220·2	96·6	1·22	117·9	2·28	220·2
Bossing (Twin Screw)															
Minor Appendages															
Total Displacement for "B.M."	261·2	2·364	617·4	2·114	552·3	450·6	3·478	1567·5	2·236	1007·8	654·4	4·578	2995·6	2·446	1600·7
Shell	4·3			A		5·4			A		6·1			A	
TOTAL DISPLACEMENT	265·5					456·0					660·5				

ABBREVIATIONS :—

O = Ordinate.	C.L. = Centre of Displacement Length.				
L = Horizontal Lever in Intervals.	V.C.B. = Vertical Centre of Buoyancy.		*Name.*	*Date.*	
O.L. = ,, Moments for C.G.	L.C.B. = Longitudinal ,, ,,	Calculation made by			
$O.L^2$ = ,, Moments for Inertia.	S. = Sum of Half Areas of Appendage.	,, checked by			
O^3 = Cubes of Ordinates.					

And^w Reid & Comp^y L^td Newcastle on Tyne.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.

NINETEENTH SESSION, 1902-1903.

PROCEEDINGS.

THE SEVENTH GENERAL MEETING OF THE SESSION WAS HELD IN THE LECTURE HALL OF THE SUNDERLAND LITERARY SOCIETY, FAWCETT STREET, SUNDERLAND, ON THURSDAY EVENING, APRIL 23RD, 1903.

JOHN TWEEDY, ESQ., J.P., PRESIDENT, IN THE CHAIR.

The SECRETARY read the minutes of the previous meeting held at South Shields on Friday evening, March 20th, 1903, which were confirmed by the members present, and signed by the President.

The PRESIDENT appointed Mr. Alfred Harrison and Mr. E. J. Crosier to examine the voting papers for new members, and the following gentlemen were declared elected:—

MEMBERS.

Cooper, Shapoorjee P., Engineer, Luxmi Mills, Sholapur, British India.
Crighton, A. T., Superintendent Engineer, 27, Canal des Brasseurs, Antwerp.
Jones, Arthur P., Superintendent Engineer, Messrs. Hungarian Levant S.S. Co., Ltd., Constantinople.
Singleton, Thomas, Superintendent Engineer, 46, Drury Buildings, Water Street, Liverpool.
Thomas, Harold, Ship Draughtsman, 30, Cromwell Road, Belfast.

ASSOCIATE.

King, Ernest, Accountant, Messrs. Mellowes & Co., Corporation Street, Sheffield.

GRADUATE.

Lamb, Robert, Apprentice, 165, Park Road, Newcastle-upon-Tyne.

The PRESIDENT said—I wish to draw your attention to the fact that certain officers of the Institution must retire every year. You will find the names of those who retire this year in the circular you have before you, and certain gentlemen have been nominated for election: these also are given in the circular. If any of you have any other names to suggest, now is the proper time to do it.

The following is the extract from the agenda referred to by the President:—

In accordance with Article X. of the Constitution, the following gentlemen will retire from the Council:—

President.—Mr. John Tweedy (eligible for re-election).

Vice-Presidents.—Messrs. A. Coote, John Dickinson, and C. D. Doxford (eligible for re-election).

Hon. Treasurer.—Mr. G. E. Macarthy (eligible for re-election).

Ordinary Members of Council.—Messrs. Richard Hirst, M. C. James, D. R. Macdonald, T. S. Short, and W. G. Spence (not eligible for re-election as Councilmen).

In accordance with Bye-law 11, the President, on behalf of the Council, nominated the following gentlemen to be ballotted for to fill the vacancies:—

President.—Mr. John Tweedy (Neptune Works, Walker).

Vice-Presidents.—Messrs. A. Coote, John Dickinson, C. D. Doxford, and W. G. Spence (three to be elected).

Hon. Treasurer.—Mr. G. E. Macarthy.

Ordinary Members of Council.—Messrs. David Andrew, Henry James Dobson, Edwin Griffith, James Marr, Thomas Shaw, and Henry Walker (five to be elected).

N.B.—Any Member can add to the above Nominations at the Meeting now convened (see Bye-law 11).

The name of Mr. Charles A. Bushell was added to those nominated as Ordinary Members of Council.

PROPOSED AMENDED SUPPLEMENTARY BYE-LAW, No. XI.

The PRESIDENT said—I have now, on behalf of the Council, to give notice that, at the Closing Business Meeting of the Session, to be held in Newcastle-upon-Tyne, on Friday, May 22nd, 1903, I will move that No. XI. of the Supplementary Bye-laws, relating to the Graduate Section, shall be rescinded, and the following inserted in its place:—

Each paper read before the Section should not exceed ten octavo pages of letterpress, and the illustrations not greater in extent than will cover two quarto plates. All manuscripts to be written on one side of the paper only, and be signed by the author. The date on which the paper was read must be inserted after its title.

At the end of each Session a Special General Meeting of the Graduates shall be convened at seven days' notice to adjudicate upon the merits of the papers read during that Session. The selection of the three best papers shall be made by ballot, and those papers marked first, second and third in degree of merit shall be placed in the hands of the Secretary of the Institution, not later than the 31st of May in each year, for the approval of the Council. These three papers will be submitted to the Reading Committee, and either one or two may be recommended to be printed as an Appendix to the current volume of the *Transactions* of the Institution; the Council reserving the right to decline to give any award, or to print any of the papers, should it consider the standard insufficient.

The submission of any paper for an award, and its publication prior to its submission to the Special General Meeting, is entirely at the option of the author of such paper; but if it be published without the sanction of the Council it shall be ineligible for competing in the Award Competition, and no reference must be made to its having been read before the Graduate Section of the Institution.

All papers submitted for awards shall become the property of the Institution, and if published in the technical journals the permission of the Council must be previously obtained and the name of the Institution must be attached.

Mr. W. H. WADDINGHAM—I give notice, on behalf of Mr. G. Nelson, Chairman of the Graduate Section, that he will, at the Closing Business Meeting of the Session, move the following amendment:—

Each paper read before the Section should not exceed ten octavo pages of letterpress, and the illustrations not greater in extent than will cover two quarto plates. All manuscripts to be written on one side of the paper only, and to be signed by the author. The date on which the paper was read must be inserted after its title.

All papers submitted to the Reading Committee shall be placed in the hands of the Secretary of the Institution, not later than the 31st of May in each year.

Of these papers submitted to the Reading Committee either one or two may be recommended to be printed as an Appendix to the current volume of the *Transactions* of the Institution, the Council reserving the right to decline to give any award or to print any of the papers should it consider the standard insufficient.

The submission of any paper for an award, and its publication prior to its submission, is entirely at the option of the author of such paper, but if it be published without the sanction of the Council, it shall be ineligible for competing in the Award Competition, and no reference must be made to its having been read before the Graduate Section of the Institution.

All papers submitted for awards shall become the property of the Institution, and if published in the technical journals the permission of the Council must be previously obtained, and the name of the Institution must be attached.

Mr. W. H. DUGDALE—You have taken out the special meeting of the Graduates. That really is the point?

Mr. WADDINGHAM—Yes.

The PRESIDENT—The notice will be brought before the Council at its next meeting.

The discussion of Mr. J. Denholm Young's paper on "Loss of Power in Steamship Vibrations" was resumed.

The discussion on Mr. F. H. Alexander's paper on "A Displacement Table for Use with the Tchebycheff Formula," was resumed.

Mr. ARCHIBALD HOGG read a paper on "Some Points in the Construction of Large Steel Steamers and the Riveting of Lapped Butts."

RESUMED DISCUSSION ON MR. J. DENHOLM YOUNG'S PAPER ON "LOSS OF POWER IN STEAMSHIP VIBRATIONS."

The PRESIDENT said—The discussion will be resumed on Mr. J. Denholm Young's paper on "The Loss of Power in Steamship Vibrations."

The SECRETARY said—I have to read the following communication on the subject, which was sent to Mr. Denholm Young by Admiral Melville, of the United States Navy:—

WASHINGTON, D.C., 10*th March*, 1903.

Mr. J. DENHOLM YOUNG,
c/o North-East Coast Institution of Engineers
and Shipbuilders,
Newcastle-upon-Tyne, England.

DEAR SIR,

Your paper on the "Loss of Power in Steamship Vibrations," which was thoughtfully sent me, is of very considerable interest, and directs attention to one of the most important phases of the problem, the question of the transference of energy, a point of view which has been far too much overlooked. When we rise above the more superficial parts of the subject, consisting of measuring unbalanced forces and couples, estimated for the engine sitting on a rigid base, to consider the profound physical problem, we are at once confronted by the question of the supply and absorption of energy.

In my current paper in *Engineering*, I take up this question in Appendix I., which will no doubt interest you. As the loss of horsepower in transverse vibration was found to be so small, I contented myself with merely mentioning the fact, since other questions were pressing for attention. You will find this stated in connection with the kindred question of the loss of horsepower from torsional vibration of shafting, which I show may be very large.

All through Section V. and Appendix II., when giving an account of Frahm's investigation and my own observations, the same point of view is maintained.

In equation (10A), Appendix I., we have the loss of energy per vibration

$$SE = \pi F a_s$$

where F is the maximum intensity of the unbalanced *force* of any period, when there is exact synchronism, calculated on the supposition that the engine foundation is rigid; and a_s is the response at the point of application of the force.

Thus for F = one ton and a vibration of one inch travel ($a_s = \frac{1}{24}$ foot) at the rate of 100 per minute, we have a loss of horsepower

$$= \frac{\pi \times 2{,}240 \times 100}{24 \times 33{,}000} = \cdot 89.$$

Applied to any actual case, where the vibration is within allowable limits the fraction of loss will be found always to be exceedingly small.

I also show how the loss from an unbalanced couple may be estimated.

I find viscosity of the metal of the hull a very feeble agent which is quite negligible for the longer periods of vibration. For these long vibrations undoubtedly the eddying resistance of the water is by far the preponderating agent.

I have been pleased to examine your paper.

Very respectfully,

GEO. W. MELVILLE,

Rear-Admiral and Engineer-in-Chief, U.S. Navy.

The PRESIDENT—I am sure it is very agreeable to us all to find Admiral Melville recognizing the good work done by a member of this Institution in his paper. Admiral Melville, as you know, has devoted a great deal of time to the consideration of vibration questions. Mr. Young has entered upon a field of investigation in which very little has been done. It is a field which will well repay cultivation. The question he raises is an abstruse one, and, even if its consideration should not lead to any appreciable reduction in the power required to drive a vessel at any given speed, indirect benefits are certain to result from an investigation carried out in the spirit of Mr. Young's paper.

For some years I have been associated with others in some endeavours to reduce as far as possible the vibration of steamships fitted with engines having four or more cranks on each

line of shafting. In the early period of our work one of our difficulties was to convince shipowners that engines, as usually fitted at that time, were capable of producing any vibration in a structure apparently so substantial as a steamship. That time has long passed. The tendency now is to attach to the engines, separated from their shafts and propellers, a greater load of blame than experience appears to justify. Besides the engines, the propeller is frequently a source of vibration.

A ship has just arrived in New York, the propellers of which, of large diameter, were machined on a tool specially built for the purpose of removing as far as possible the irregularities of form which so often result in disagreeable motion at the stern. In view of the reports about other large ships to be built in England, it is worth noticing that the enterprise of our German competitors has been such that, having recognised the possibility of vibration being produced by the malformation of a propeller, they at once proceeded to produce a machine which turns the propeller true. It is also satisfactory that, as you are all aware, most elaborate investigations are being made into the question of torsional vibration. Some of the ablest experimentalists in this country, in Germany and in America, are engaged in the consideration of such questions, while others, including our friend Mr. Young, find occupation in the study of the more profound aspect of the question which he treats so well in his paper. In closing the discussion it will be your wish that the Secretary be asked to convey to him the hearty thanks of this Institution for having honoured us with so interesting a piece of work, which must have occupied a great deal of his very valuable time. I propose that the Secretary convey to Mr. Young our hearty thanks.

The proposition was carried with acclamation, and the discussion was closed, it being understood that Mr. Young would reply at the next meeting.

RESUMED DISCUSSION ON MR. F. H. ALEXANDER'S PAPER ON "A DISPLACEMENT TABLE FOR USE WITH THE TCHEBYCHEFF FORMULA."

The SECRETARY said—Mr. Heck, who is unable to be present this evening, wishes me to state that having, since the last meeting held at South Shields, tested with more care many curves with a less number of ordinates, the values of which were determined by calculation, he finds that the method described by Mr. Alexander gives very accurate results, quite equal to Simpson's method; and to ensure the same accuracy with the trapezoidal method a greater number of ordinates are required. He regrets that he is unable to be present.

Mr. T. SHAW said—I am sure we will all agree that the paper read by Mr. Alexander is one of very great interest to all naval architects, and more particularly to those engaged in calculations every day in the drawing office. The system, so far as I am aware, is unique, being a combination of Tchebycheff and Simpson—longitudinally of Tchebycheff and vertically of Simpson. The displacement table and other calculations are put in a very compact form, and now that actual figures have been added readily explains itself. I think, however, before adopting any new system it would certainly be advisable to find out three essential points, viz., accuracy, time, and chances of error in the manipulation of the figures. On comparing the results, by the two methods, of special figures whose functions may be determined by independent mathematical formulæ, it will be noted that there is very little difference, and if the intervals had been wider spaced with sub-division at ends (giving the same number of ordinates) the result by Simpson's would have been more accurate. The vertical centre of buoyancy of the bottom appendage is obtained by Morrish's formulæ, and if the vessel is of unusual form a considerable error may be caused by being forced to use same. Not being able to use a cross check, as is usual with Simpson's, is also a disadvantage, and the method proposed by Mr. Alexander does not altogether overcome the objection.

The question of time is, I consider, of secondary importance and should be subservient to accuracy, but I cannot agree with Mr. Alexander when he states that a saving may be made of one-third to one-half. In the example given the length of the vessel, viz., 200 feet, lends itself readily to the various formulæ, but, supposing this was altered to 213 feet the extra work would be more pronounced than if using Simpson's rule.

To obtain a first displacement by Simpson's it is only necessary to put in sections on the body plan, and the calculation being made any corrections can be effected before running the lines, whereas with Tchebycheff, lines would have to be run, entailing more than twice the work, and as pointed out by Mr. Alexander, it is more difficult to read off figures from the lines than the body plan.

With regard to the chances of error in the manipulation of figures, the proposed system has an advantage except in the cross check of displacement calculation.

I do not think the system would be practicable in working some of the calculations usually done in a drawing office, viz., those connected with launching and trim of oil vessels where the alteration is excessive.

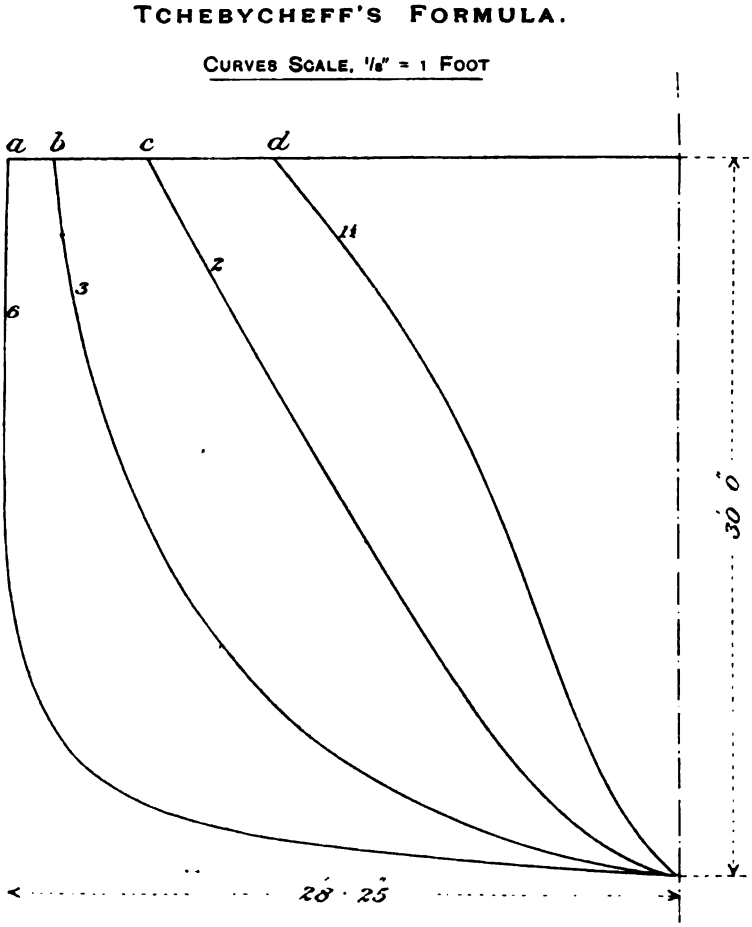
The example sheet is the most compact one I have seen and if the lines have been run and only the final calculations are required there may be a slight gain in time but not sufficient to warrant a change from an established system. Mr. Alexander must have spent a considerable time in preparing this excellent paper and I would like to thank him for bringing such an interesting subject before us.

Mr B. C. Laws (a visitor, by permission of the President) said—I am much obliged to your chairman for allowing me, not being a member of this Institution, to make a few remarks upon the paper on Tchebycheff's formula.

I have read Mr. Alexander's paper with a good deal of interest, enhanced by the fact that at the time when Professor Biles read his paper in Glasgow, and to which Mr. Alexander has referred, I had made some comparative calculations with a view to ascertaining on my own account the relative merits of Tchebycheff's rule and Simpson's rule in their application to ships' curves. The results I propose to give you now.

Mr. Alexander, in his paper, unfortunately, does not go so fully into the complete rule as might have been desired, but confines himself only to one formula of that rule, viz., the 2 ordinate formula.

With Tchebycheff's complete rule there are no less than 7 different formulae or methods of setting off ordinates, and known



as the 2, 3, 4, 5, 6, 7 and 9 ordinate formulae. The author has apparently assumed the 2 ordinate formula, or rather a continued application of it, as being the one giving the greatest accuracy. This undoubtedly is a moot point; indeed it is generally understood by those who have to do with calculations

in ship design that the higher ordinates give the best results. To test the relative merits of Tchebycheff's and Simpson's rules I have selected 4 curves of vertical section and of varying co-efficients of area (see Sketch, p. 179), the co-efficients ranging from ·9331 to ·466; these curves have been carefully subjected to these rules, and the results obtained compared with the similar readings obtained by the integrator. The accuracy of the integrator was such that on running it very carefully over a square of known area the error was found to be only 5 in 18,000 or ·027 per cent. too great.

The method of applying the different formulae of Tchebycheff's rule is fully explained in the paper by Professor Biles already referred to.

The method is to set out, from the middle point of base of the curve, positions of the ordinates according to Table B (p. 183), each factor there shown being multiplied by the half length of base to obtain these positions: the mean of the ordinates erected at these points gives the mean ordinate of the curve.

Table A (pp. 181-182) shows the results of the comparison: the percentage errors being given in each case for clearness. This table shows (1) that, broadly speaking, the greater the number of ordinates taken the greater is the accuracy obtained, the 2 ordinate Tchebycheff rule showing the greatest inaccuracy, and this applies both to areas and moments; (2) we find a surprising uniformity in the results obtained by Simpson's rule, while those of Tchebycheff show a considerable variation; (3) we find the balance of accuracy considerably in favour of Simpson's rule.

Taking a curve of known form such as a curve of sines, the equation of which is $Y = x \sin x$, and length of base 20 feet, we have by integration the correct area 162·12 square feet, and the areas by:—

Tchebycheff's 9 ord. rule = 162·6 sq. ft.; and Simpson's 9 ord. = 162·25 sq. ft.
,, 5 ,, ,, = 163·16 ,, ,, ,, 5 ,, = 161·63 ,,

showing again a closer agreement of Simpson's than of Tchebycheff's. Applying these results to a vessel, say of 10,000 tons displacement, and for the sake of comparison taking the 9 ordinate Tchebycheff rule *v.* the 11 ordinate Simpson, we would find an error of about 60 tons and 10 tons respectively, the former

TABLE A.—COMPARISON OF TCHEBYCHEFF'S AND SIMPSON'S RULES WITH THE INTEGRATOR IN OBTAINING AREAS AND CENTRES OF GRAVITY.

\+ and − signs respectively indicate results in excess of or below Integrator readings, and C. G.'s are in all cases taken above base.

(*a*) Curve Coefficient, ·9331. Area by Integrator, 1581·6 square feet. C. G. by Integrator, 15·91 feet above base.

No. of Ordinates.	TCHEBYCHEFF'S. Areas.	°/₀ error.	C. G.	°/₀ error.	No. of Ordinates.	SIMPSON'S. Areas.	°/₀ error.	C. G.	°/₀ error.
2	1629·0 sq. ft.	+ 2·997	15·34	− 3·583	3	1568·78 sq. ft.	− ·810	16·01	+ ·628
3	1617·0 ,,	+ 2·238	15·486	− 2·665	5	1582·19 ,,	+ ·037	15·856	− ·339
4	1608·6 ,,	+ 1·67	15·60	− 1·95	7	1583·48 ,,	+ ·119	15·845	− ·409
5	1608·96 ,,	+ 1·73	15·603	− 1·93	9	1584·89 ,,	+ ·208	15·838	− ·452
6	1605·24 ,,	+ 1·495	15·642	− 1·684	11	1584·62 ,,	+ ·191	15·84	− ·440
7	1602·18 ,,	+ 1·301	15·671	− 1·503	13	1584·41 ,,	+ ·178	15·84	− ·440
9	1595·40 ,,	+ ·872	15·737	− 1·087					

(*b*) Curve Coefficient, ·7771. Area by Integrator, 1224 square feet. C. G. by Integrator, 17·3 feet above base.

2	1244·4 sq. ft.	+ 1·6	16·895	− 2·341	3	1218·78 sq. ft.	− ·426	17·346	+ ·266
3	1236·8 ,,	+ 1·045	17·02	− 1·618	5	1224·18 ,,	+ ·015	17·23	− ·405
4	1232·7 ,,	+ ·711	17·10	− 1·156	7	1224·30 ,,	+ ·0245	17·22	− ·462
5	1233·36 ,,	+ ·765	17·116	− 1·063	9	1227·19 ,,	+ ·261	17·207	− ·537
6	1233·18 ,,	+ ·75	17·126	− 1·006	11	1225·8 ,,	+ ·147	17·203	− ·561
7	1230·42 ,,	+ ·524	17·152	− ·855	13	1225·8 ,,	+ ·147	17·215	− ·491
9	1227·78 ,,	+ ·308	17·179	− ·700					

TABLE A.—*Continued.*

(*c*) Curve Coefficient, ·5973. Area by Integrator, 795·6 square feet. C. G. by Integrator, 18·75 feet above base.

No. of Ordinates.	TCHEBYCHEFF'S. Areas.	°/₀ error.	C. G.	°/₀ error.	No. of Ordinates.	SIMPSON'S. Areas.	°/₀ error.	G. C.	°/₀ error.
2	808·8 sq. ft.	+ 1·66	18·47	− 1·493	3	787·16 sq. ft.	− 1·060	18·73	− ·107
3	803·22 ,,	+ ·957	18·55	− 1·062	5	794·18 ,,	− ·178	18·68	− ·373
4	800·1 ,,	+ ·566	18·60	− ·800	7	793·88 ,,	− ·216	18·68	− ·373
5	800·1 ,,	+ ·566	18·60	− ·800	9	796·2 ,,	+ ·076	18·67	− ·427
6	801·1 ,,	+ ·682	18·62	− ·693	11	795·01 ,,	− ·074	18·67	− ·427
7	799·2 ,,	+ ·453	18·63	− ·640	13	794·66 ,,	− ·118	18·68	− ·373
9	796·56 ,,	+ ·12	18·66	− ·480					

(*d*) Curve Coefficient, ·466. Area by Integrator, 479·2 square feet. C. G. by Integrator, 19·75 feet above base.

2	482·4 sq. ft.	+ ·667	19·265	− 2·456	3	477·6 sq. ft.	− ·334	19·88	+ ·658
3	482·4 ,,	+ ·667	19·464	− 1·448	5	477·96 ,,	− ·259	19·65	− ·506
4	480·3 ,,	+ ·229	19·604	− ·739	7	478·44 ,,	− ·158	19·65	− ·506
5	481·92 ,,	+ ·568	19·58	− ·861	9	479·175 ,,	− ·005	19·66	− ·455
6	481·38 ,,	+ ·455	19·63	− ·607	11	479·11 ,,	− ·019	19·63	− ·608
7	481·38 ,,	+ ·455	19·61	− ·709	13	478·32 ,,	− ·184	19·64	− ·557
9	477·06 ,,	− ·446	19·56	− ·962					

of which would hardly be permissible in a vessel designed to carry a certain deadweight on a particular draft.

Apart from these results, I consider that the extra labour involved in setting out the ordinates is in no way a set off against Simpson's equal spacing with easy multipliers, more especially as the ordinates have to be read from overlapping water lines, and eventually Simpson's rule has to be used for completing the calculations in a vertical direction.

Even in obtaining cross curves of stability the advantage of Tchebycheff's rule seems hardly apparent when one considers the ease and quickness with which the results may be obtained with the integrator.

TABLE B.—SHOWING MULTIPLIERS OF "HALF LENGTH OF BASE" TO GIVE THE POSITION OF ORDINATES FROM MIDDLE POINT OF BASE.

No. of Ordinates.	Multipliers.								
2				·5773.					
3			0.		·7071.				
4			·1876.		·7947.				
5		0.		·3745.		·8325.			
6		·2666.		.4225.		·8662.			
7	0.		·3239.		·5297.		·8839.		
9	0.	·1679.		·5288.		·6010.		·9116.	

Adverting to sub-paragraph (*c*) (p. 157) of Mr. Alexander's paper, the figures I have put before you hardly bear out what is there stated, and indeed the testimony of accuracy over and above the usual computation by Simpson's rule seems not to have been quite universal.

On page 159, the author suggests that accuracy is obtainable by a smaller number of ordinates in fine vessels than in those of fuller form. The results as shown in the table hardly appear to support this view, as generally speaking, in all cases whether the curve were of full or fine form, the higher ordinates gave the best results; and I think this is what one would naturally expect; for the reason that "the lines joining the ends of the ordinates approach more nearly to the actual curve as the number of ordinates is increased, until when the number is indefinitely great we arrive at the curve itself."

A good general method, and one which I have found it well to adopt in calculating the area of a curve, is to choose about as many ordinates as would fairly reproduce the curve,

Mr. Alexander, by choosing the 2 ordinate rule, has been successful in putting it into the compact and concrete form of a table, and by this means has cut away a great deal of the prejudice which has existed against the Tchebycheff formula. But on the whole I think it hardly desirable or advisable to forsake Simpson's rule for this one.

The discussion stood adjourned.

SOME POINTS IN THE CONSTRUCTION OF LARGE STEEL STEAMERS AND THE RIVETING OF LAPPED BUTTS.

By ARCHIBALD HOGG, Member.

[Read before the Institution in Sunderland, on April 23rd, 1903.]

The object of this paper is twofold, viz., to draw attention, firstly, to the structural strength of large and full-formed steamers; and secondly, to suggest a new principle of lap butt riveting. The periodical additions to Lloyd's Rules and the necessity for strengthening many large ships appear to afford sufficient reason for introducing this subject for discussion.

It may not be out of place to remind ourselves that a steamer is designed for the purpose of carrying human lives and merchandise across the ocean, and, what is more, of carrying them safely, so that surely her first qualification should be that of being able to easily withstand the severe and continuous stresses to which we know she will be subjected.

It is a generally accepted fact that a ship meets her greatest stresses when she is labouring in a head sea, poised one moment on a wave crest and the next moment plunging into another wave and so on intermittently for days. When we consider the weight of these vessels, say 8,000 to 15,000 tons and above, we can have no doubt of the reality of the stresses and the necessity of adequate strength of hull.

It is sufficient for this paper to consider only those stresses which arise from hydrostatic pressure and wave action. The deeper immersion of the ship in way of the wave crest subjects the shell plating to very great hydrostatic pressure. When the wave crest reaches amidships, the hull at that part is subject to the maximum hogging stress in addition to the local hydrostatic stress, the ends being also under the action of bending and sheering forces. The forward end of the ship is exposed to additional stress due to the resistance of the water as the vessel plunges into and forces her way through the wave.

The hydrostatic pressure to a certain extent governs the

thickness of shell plating and forms a basis for the general scantlings to be eventually used. For example: Suppose the height of wave crest to be 40 feet above the keel and the frame spacing 26 inches centres and 3½ inch frame flange, and take a portion of the shell plating 12 inches wide, we have thus a girder whose length of 22½ inches is uniformly loaded with a pressure of ·095 tons per inch length of girder. Taking 7 tons per square inch as a working stress, then the plating requires to be $\frac{1}{2}\frac{3}{0}$ of an inch in thickness to withstand the hydrostatic pressure alone. The reaction of this plating, as a girder, comes on the frames alone without their receiving any assistance from the shell plating. It is evident, therefore, that some portion of the shell plating at midships is wholly used in resisting the hydrostatic pressure and cannot be taken into account as assisting the longitudinal strength of the vessel. The proportion of the plating which is available for this latter purpose will depend on what is added to the thickness required for hydrostatic pressure alone.

Another important decrease in the material effective for resisting longitudinal stresses takes place at the keel, which is considered the backbone of the vessel. The usual method of construction at this part is to make the centre girder continuous fore and aft, and to cut the frames and floors on either side, the strength being made good by means of vertical connecting angles; but this connection alone is not adequate, and a part of the keel plate and middle line strake of the tank top is pressed into use to complete the connection. The material thus used cannot be available to meet the hogging and sagging stresses, and, as about ½ inch of the thickness of these plates is used, the loss is very considerable. A similar loss takes place at the margin plates.

Let us now consider the amount of material at the midship body which is effective in resisting the longitudinal structural stress. The usual text-book practice is to consider the whole of the material as effective when under compression and ⅘ of it when under tension, but this is over-estimating, as proper allowance is not made for iron rivets, weak butts, *i.e.*, the butts being of less strength than the solid plate, and the other losses before mentioned. The following is a summary of some of the actual losses (that due to the cargo, though considerable, is here neglected):—

MATERIAL UNDER COMPRESSION.

		Per cent.
A loss due to the use of iron rivets		5½
B ,, ,, weak butts		5
C ,, ,, hydrostatic pressure, say		20
D ,, ,, frame connections, say ...		5
Total ...		35½

Explanation of Item A: Suppose the shell plating to be connected to the frame by rivets 1 inch in diameter, spaced 7 inches centres, the mean diameter of the countersink is 1·3435 inch, which leaves 5·6565 inches of steel plating. Assuming the safe strength of 5 tons for iron and 7 tons for steel and plating 1 inch thick, the actual stress works out at 46·32 tons, against 49 tons if all the material were taken at 7 tons, and this is equivalent to a loss of 5½ per cent.

Item B: Assuming the strength of the lapped butt under compression as 78 per cent. of the solid material, and also that 4 butts will occur in the same frame space on a half girth of hull of, say, 90 feet, we have, say, 20 feet of the girth having a loss of 22 per cent., which is equivalent to a loss of 4·4 feet or 5 per cent. of the total girth.

MATERIAL UNDER TENSION.

	Per cent.
A loss due to holes punched and countersunk at frame line ..	19
B ,, ,, weak butts	3
Total ...	22

Explanation of Item A: Assuming same conditions as held for material under compression, the area of the effective steel multiplied by 7 tons equals 39·6 tons, against 49 tons for solid material, and this is equivalent to a loss of 19 per cent.

Item B: The strength of the butt under tension is, say, 68 per cent. of the solid plate or a loss of 32 per cent., from this deduct the above 19 per cent., which leaves a further loss of 13 per cent. per butt, and assuming 4 butts as before, we have a final loss of 3 per cent. on the total area.

We have now seen how and to what extent the material in the hull may be taken into account to resist the stresses that are brought to bear on it, and it becomes necessary now to examine the greatest working stresses per square inch which are commonly accepted, and to determine whether or no they are consistent with the known strength and qualities of mild steel and iron rivets as used in ship construction.

Mr. J. Bruhn, in a recent paper entitled, "Some points in Connection with the Riveted Attachments in Ships," read at Glasgow, gave the following list of stresses in tons per square inch of material in way of frame rivets, assuming vessels of a form having ·78 coefficient:—

Length of Vessel.	Stress.	Length of Vessel.	Stress.
350	7·9	550	9·1
400	8·2	600	9·6
450	8·5	650	9·75
500	8·9	700	9·9

Of course with ships of fuller forms the stresses would be correspondingly increased.

These figures practically agree with the results of calculations, made by the writer, of some vessels built to Lloyd's Rules and may be taken as those usually employed in comparing the strength of a proposed vessel. It will be observed that the stress is not constant, but increases with the dimensions of the ship. That this should be so does not appear correct, at any rate for vessels between 250 and 500 feet in length, which lengths correspond to those of the waves which can be met with, because the material used in the construction of all the vessels is of the same nature and, therefore, has a constant safe working stress, which should never be exceeded. The only justification for using varying stresses appears to be that, in actual sailing, the effect of the action of the waves is not considered so severe in large as in small and medium ships, but such an assumption does not appear to be justifiable, for the stress is an actual one, not an imaginary one, and is constant, as long as the vessel is floating amongst waves equal to her own length. What then is the limiting stress per square inch at which steel may be worked. The breaking stress of mild steel is 30 tons per square inch, the limit of elasticity about 14 to 15 tons, while a permanent set, although slight, is apparent at a stress of 8¼ tons per square inch. This latter should be the limiting load imposed on the material at any time. In fixing the scantlings of a ship, and bearing in mind the serious nature of the known stresses and the possibility of their being greater, to say nothing of other likely stresses of which we are unaware, it is necessary that a smaller stress per square inch should be employed. In the writer's opinion this should be 7 tons for vessels ranging from

250 to 500 feet in length, these being the sizes of vessels to which this paper is intended to draw attention. Even at 7 tons there is no allowance for loss due to corrosion.

Coming now to the second part of this paper, the riveting of lapped butts. The object is to make the connection as strong as

TABLE I.

Thickness of Plate in 20ths of an Inch.	Dia. of Rivets in Inches.	Strengths.					
		Solid Plate.	Punched Plate at Edge Row.	Countersunk Plate at Edge Row.	Shearing of Rivets.	Bearing of Plate.	Punched Plate at 2nd Row and Shearing Edge Row Rivets
5	⅝	100	62	66	80	66	—
6	¾	100	62	66	78	65	—
7	¾	100	62	66	66	65	—
8	¾	100	65	71	75	84	—
9	⅞	100	65	71	78	85	—
10	⅞	100	66	72	74	91	89
11	⅞	100	68	74	75	101	93
12	⅞	100	69	76	79	115	80
13	1	100	66	73	78	109	87
14	1	100	68	75	78	118	81
15	1	100	69	76	78	125	75
16	1⅛	100	68	74	79	121	76
17	1⅛	100	68	75	81	132	71
18	1⅛	100	69	76	82	142	76
19	1⅛	100	70	78	85	155	93
20	1⅛	100	70	79	83	159	71

possible, compatible with other requirements, such as caulking, etc. The strength of a butt is equal to the strength of the plate through the endmost row of rivets, the spacing of which is determined by the thickness of the plate. The thicker the plate, the greater can be the distance between the rivets for sound

caulking, and it perhaps is a matter of opinion what this spacing should be. The writer's ideas on this point are embodied in Fig. 2 (Plate XX.) and, using this principle of spacing, Table I. (p. 189) has been compiled showing the percentage of strength at various places in the butt, for each thickness of plate from $\frac{5}{20}$ to $\frac{20}{20}$

TABLE II.

Thickness of Plating in 20ths of one Inch.	Dia. of of Rivets in Inches.	Breadth of Lap in Inches.	Number of Rows of Rivets.	Spacing of Rivets Centre to Centre in Inches.		Strength—Percentage of Solid Plate.	Extra Rivets for Butt under Compression per Space in Endmost Row Rivets.
				Endmost Rows.	Inner Rows.		
5	$\frac{5}{8}$	$4\frac{1}{4}$	2	$2\frac{1}{2}$	—	62·2	$\frac{1}{2}$
6	$\frac{5}{8}$	5	2	3	—	62·4	$\frac{1}{2}$
7	$\frac{5}{8}$	5	2	3	—	62·5	1
8	$\frac{5}{8}$	$7\frac{1}{2}$	3	$3\frac{1}{2}$	$3\frac{1}{2}$	65·8	1
9	$\frac{7}{8}$	9	3	4	4	65·6	1
10	$\frac{7}{8}$	9	3	$4\frac{1}{4}$	3	66·8	1·15
11	$\frac{7}{8}$	11	4	$4\frac{1}{2}$	$4\frac{1}{2}$	68·0	1·25
12	$\frac{7}{8}$	11	4	$4\frac{3}{4}$	$3\frac{3}{4}$	68·8	1·3
13	1	$12\frac{1}{2}$	4	5	$4\frac{1}{2}$	67·5	1·17
14	1	$12\frac{1}{2}$	4	$5\frac{1}{4}$	$3\frac{3}{4}$	68·3	1·3
15	1	$12\frac{1}{2}$	4	$5\frac{1}{2}$	$3\frac{3}{8}$	69·2	1·5
16	$1\frac{1}{8}$	$14\frac{1}{2}$	4	$5\frac{3}{4}$	4	68·0	1·3
17	$1\frac{1}{8}$	$14\frac{1}{2}$	4	6	$3\frac{1}{2}$	68·7	1·3
18	$1\frac{1}{8}$	$17\frac{3}{4}$	5	$6\frac{1}{4}$	$4\frac{1}{2}$	69·3	1·3
19	$1\frac{1}{8}$	$17\frac{3}{4}$	5	$6\frac{1}{4}$	$3\frac{7}{8}$	70·3	1·2
20	$1\frac{1}{8}$	$17\frac{3}{4}$	5	$6\frac{5}{8}$	$3\frac{3}{4}$	70·2	1·5

of an inch. Table II. shows the corresponding arrangement of rivets in each butt. It will be noticed that the spacing for all rows is by no means uniform for each thickness of plate. The following is a list of the safe stresses used in compiling the tables—the factor of safety is about 4:—

	Tons per square inch.
Plate unpunched	7
Plate punched	6
Plate punched and countersunk	7
Rivets of iron	4¾
Bearing of plate	8½

Experiments on steel plates riveted together by iron rivets show that the rivets sheer at 19 tons per square inch of area, including the $\frac{1}{16}$ inch extra diameter added by punching, so that this 19 tons includes the overcoming of friction between the two plates due to the contraction of the rivet.

The lap butts shown on the tables have been calculated under tensile stress, but these butts, especially at midships, are continuously subjected to compression as well as tension. If it is desired to make the lap butt when under compression equal in strength to the solid plate, more rivets are required; the number per space of rivets on the endmost rows for each thickness is given in Table II. The riveting should always be as near this as possible, at midships and at top and bottom of the hull.

The riveting in these tables applies only to that portion of the plate between the edge seams, the plate in way of the edge seams must be considered separately. Owing to the customary close spacing of the rows of rivets in the edge seam the strength of the plate at this part of the butt is reduced to 55 per cent. of the solid plate, as against, say, 70 per cent. in the butt proper, and the sheering of the rivets is practically equal to the solid plate, in a quadruple lap, when packing is used. When, however, scarphing is adopted the bearing of the scarphed plate is about 56 per cent. of the strength of the solid plate, but an improvement on this might be made, especially at midships, by widening the seam so as to increase the efficiency of the plate, making it more in keeping with the riveting, in which case the scarphing would need to be given up and packing adopted.

We have now to consider to what extent in the vessel's plating it is necessary to have the full lap butt connection. In Fig. 1 (Plate XX.) the material contained by the two triangles, ABE and CDE, is being utilized in resisting the bending moment when the crest of the wave is at midships, but as the wave travels from forward to aft it follows that the greatest bending moment moves with it, especially when the crest is near midships, so that it is safe to say that all the material in the area contained by

ABGDCF is used in resisting it. Therefore, within this area the butt fastenings should be of the full strength in accordance with the thickness of the plate at each part. The efficiency of the butt connection in the remaining material is governed by the magnitude of the action of the sheering forces and hydrostatic pressure. The former only works out at about 2 tons per square inch of material available to meet it, so that the water pressure and local strains due to shocks from fenders, etc., are the main features in determining what the fastening here should be. In the writer's opinion these should be taken from the suggested tables, thus giving the whole of the butts in the shell and decks, etc., the full value (tension butts).

A recent addition to Lloyd's Rules requires that some of the shell seams at the ends of large steamers above a certain length be treble-riveted. This has, no doubt, been deemed necessary on account of certain of these steamers showing indications of weakness at these parts, but to remedy this by the method adopted appears not unlike strengthening a beam which is already resting on weak supports. At this section of the vessel the bending moment, being only about half that at midships, requires only a small proportion of the material at the keel and top deck to resist it, consequently there is ample material to more than counteract the sheering force which, at this point, figures out at about 2 tons per square inch of available material. Therefore we must look elsewhere for the cause of the observed weakness. The indications of weakness in the edge seams are probably more due to panting, brought about by weak frames; and had the frames been stronger this would possibly not have taken place. This would appear to be borne out by the following facts:— (1) The length of unsupported frame at this point is greater than at midships, due to the sheer; (2) the strength of the frame section is reduced about 10 per cent; (3) the frame web is not square off the shell; (4) the load of water-pressure per foot of length of frame girder is greater on account of the fall in of the vessel's form; and (5) the load is also greater on account of the longer frame. The frames, in resisting the hydrostatic pressure, receive no assistance from the shell plating and little or none from the side stringers, because the frames are all standing the same strain, and while they bend the stringers simply yield with them. The remedy then appears to be to strengthen the frames and not the seams of the plating.

It is not supposed that this paper contains something altogether new, but it is hoped that the consideration of the points raised will be provocative of a profitable discussion.

DISCUSSION.

The PRESIDENT said—We have received a letter from Mr. Bruhn, who read a very interesting paper in Glasgow some time ago, and who is quite an expert on this question of ship riveting. He has kindly sent a valuable communication upon Mr. Hogg's paper.

I should just like to say that the thing that perhaps puzzles boilermakers when they hear a shipbuilder discuss riveting is this. The shipbuilder expresses himself, not in percentages which convey definite ideas of relation of rivets to plates, but in the language of some mysterious dictum of somebody, which provides that for a certain plate the rivets shall be in a certain position.

71, FENCHURCH STREET, LONDON, E.C.,
April 21st, 1903.

DEAR MR. DUCKITT,

The President, Mr. Tweedy, has asked me for a contribution to the discussion on Mr. Hogg's paper, and I accept the invitation, although I do not know whether I shall be able to contribute anything very new. To begin with, I must say I think the thanks of the Institution are due to Mr. Hogg for his trouble in calling attention to several important points in connection with the construction and riveting of ships.

In the first part of the paper Mr. Hogg raises the question as to what should be the proper working stress on the material of the ship, and he also deals with various sources of weakness. I do not think that the question of what the safe working stress ought to be is one of the very important ones, because as long as we are not able to calculate it, it cannot be of very great service to know what it ought to be. The quantities which we estimate are really only comparative numbers which we, for convenience sake, designate stresses. There are so many indeterminate elements affecting the actual stresses on a ship's structure, that it would be quite futile to

attempt to estimate the real stresses. The whole method of using factors of safety becomes, therefore, more or less inapplicable. The comparative stresses are usually estimated for the vessel on a wave, which must in the nature of things be of a purely hypothetical construction. It is usual to assume it of a height equal to one-twentieth of the length, which is probably higher than the actual waves met with, particularly in the case of the longer vessels. The actual stress due to the riding on a wave may therefore be less than the assumed one. Again, owing to modified pressures in the wave structure compared with still water, the stresses are again usually estimated too high. These omissions may more than balance the omission to take account of the dynamical and other forces. The list of stresses quoted from my paper should therefore be taken as comparative figures only, and, being necessarily estimated on the ordinary arbitrary basis, there is no reason to expect them to be of constant values for the various lengths of vessel, nor to take exception to their absolute magnitudes, unless it can be shown that experience has proved that the corresponding scantlings were insufficient. The fact that estimated stresses may not be actual stresses does not very materially lessen their usefulness, as they equally satisfactorily determine the standard of strength which, under any circumstances, affords the only practicable means whereby the experience gained by previous ships can be applied to other vessels of modified scantlings and distribution of weights and buoyancy. Another point in connection with the estimated stresses is of considerable importance. They are really of little value, when made by different persons, unless accompanied by a statement as to the basis on which they have been estimated, whether allowance has been made for modified wave pressures and what has been included and what excluded in the moment of inertia calculation.

With regard to the sources of weakness mentioned by Mr. Hogg, I do not think it is possible to assign quite so definite a percentage to each of them as proposed, and then to take the total as a measure of the weakening of the plating. The strength of the plating cannot, for instance, be appreciably affected by the rivet holes being filled with iron instead of steel. The rivets do not fit with sufficient perfection to make such a point of importance, and even if they did, iron rivets would, without

doubt, be able to stand compressive stresses far in excess of those that would buckle up the steel plating. The stresses on the bottom plating due to the hydrostatic pressure of a draught of water of 40 feet I make only about $4\frac{3}{4}$ tons per square inch, treating the case as an ordinary one of the bending of an uniformly loaded beam fixed at both ends and of the span assumed by Mr. Hogg. And then it must be borne in mind that the usual beam formulæ may not apply quite in such a case, and that the stresses may be even less than what these formulæ would lead one to suppose. I therefore think that the part played by the hydrostatic pressure, although important, is not quite so important as assumed by Mr. Hogg.

With regard to the second part of the paper, where the author deals with lapped butts, I must say I do not consider the method of examination he employs the safest that could be adopted. The whole comparison between the strength of the plate and that of the rivets would, by the proposed method, depend on relative working stresses, chosen in proportion to the ultimate stresses of the materials when experimented upon independently. If it were simply a question of obtaining the relative strength of a test piece of plate and its riveted attachment, then such a method of comparison might be safe. In a ship the attachments must, however, not only be strong enough to keep the plates together but they must be strong enough not to let the rivets get loose under rapidly alternating stresses combined with incessant vibrations. On the other hand, individual attachments may be assisted by the neighbouring material, but it is impossible to estimate how far such assistance may balance the additional stresses due to dynamical effects and vibrations. The actual amount of rivet power required for a given attachment in a ship can, therefore, only be safely determined by experience.

The author's proposal to space the rivets in the outer rows of lapped butts wider apart and those in the middle rows closer than is the usual practice may be a step in the right direction, as it undoubtedly tends to increase the strength of the plate through the rivet holes. But with regard to the total number of rivets in a butt the proposal really amounts to a reduction of from 10 to 25 per cent. compared with the usual practice. And this I do not think experience would warrant. While, there-

fore, the general arrangement of rivets proposed by the author might be recommendable, I do not think it should be combined with any actual reduction in the rivet power of the butts. In connection with this question of lapped butts it may perhaps be of interest to draw attention to a point I mentioned in the paper recently read at Glasgow. It was there shown that a yielding place in a structure, such as a lapped butt, where the plates are necessarily bent more or less, is a source of weakness, and that the work, which is left undone by the yielding butt, must be done by the neighbouring material, and also that it must be transmitted to this material chiefly through the rivets in the landing edges near the butt as indicated by AA (Fig. 1_B, Plate XXI.). Since then a case has happened to confirm this view. In a large steamer the rivets in the landing edges in the flat of the bottom, where the direct stresses had been unduly high, had become loose near some of the lapped butts. In other places the rivets had held, but the additional work thrown upon the adjoining strake of plating had been too much, as it was sufficient to actually fracture it in several places, as indicated by B (Fig. 1_B, Plate XXI.). With the usual arrangement of lapped butts the after ends of plates of an outside strake are not usually quite so well attached as the fore end, as the latter gets the advantage of having the butt rivets in the landing edges in double shear, whereas in the former case they are only in single shear. The butt attachment would therefore be inclined to have its place of maximum yielding on the fore side, and the greatest stresses would thus be thrown on the adjoining strake at this place. The reverse would be the case with an inside strake of plating. As a matter of fact all the fractures in the above case agreed with this view, that is to say, where an inside strake had fractured near the butt of an outside strake, it was at the frame rivets on the fore side of the butt; and where an outside strake had fractured at the butt of an inside strake, it was at the frame rivets on the after side of the butt. The lesson to be learned from this would appear to be: that, although lapped butts are satisfactory for the thinner thicknesses of plating and also for the greater thicknesses in some places of a ship's hull, they do not form an ideal attachment in the case of the thicker plates, which are called upon to do their full amount of work in direct tension or compression. In the case of thick

sheerstrakes, topside plating and keel plates double buttstraps are much to be preferred.

The author concludes his paper by a statement to the effect that he considers any indications of weakness that may have occurred at the edge attachments to be most likely due to insufficiency of transverse strength. I cannot agree with this conclusion. The facts are, briefly, that we have had a considerable amount of experience with butt riveting, particularly at the topside plating amidships, and we know that the attachments at this place are not much in excess of what is necessary to meet the stresses thrown upon them. We found by investigation that the shearing stresses on the edge attachments at about the middle of the depth in the fore and after bodies of the vessel were, in the larger fuller-formed ships coming into vogue, being increased in magnitude beyond those which had previously been found quite high enough for the rivets in the topside butts. There was, therefore, from this cause alone, good reason to expect trouble; and trouble did occur in a great number of cases at these very places where the shearing stresses were at a maximum. Comparative calculations, based on previous vessels and experience combined, point, therefore, distinctly to the cause of the trouble and therefore to the cure, which must be additional rivets in the landing edges, whether they be obtained by closer spacing or by another row. Since the reading of my paper on this subject at Glasgow there has been no want of further evidence to show that these shearing stresses were becoming too high with the increased size of cargo vessels, and also that under exceptional loading, such as might occur with large concentrated masses of water in deep ballast tanks, these stresses may become too high in vessels of much smaller sizes. Mr. Hogg refers to the shearing stress as being only 2 tons per square inch. It is not clear which stress it is that is 2 tons. Is it the stress on the plating, or is it the stress on the rivets, and in the latter case how many rows of rivets were there and what was the spacing of the rivets? Again, for what size of vessel is this stress estimated? Surely all these points would affect the magnitude of the shearing stresses considerably. If the stress is that on the rivets, it is far too low for all vessels except the very smallest. If worked out under ordinary conditions, viz., for 2 rows of rivets and usual spacing, the stress would be

about 3½ tons per square inch for a 350 feet vessel and about 7½ tons for 700 feet one. The shearing stresses alone provide, therefore, sufficient cause for the trouble experienced at the edge attachments, and there is no need for the introduction of the panting theory. But although panting may under certain conditions add somewhat to the stresses on the edge riveting, the trouble experienced would also tend to show that the straining cannot be mainly due to panting. In the first instance the position of the affected parts in a fore and aft direction has not been at the places where the panting tendency is greatest, viz., right at the ends of the vessel just clear of the panting beams, but at the places where the shearing forces are greatest, or at about one fourth the vessel's length from each end. Secondly, out of the whole number of vessels where trouble has been experienced, only a very small percentage was constructed on the deep frame principle, the arrangement found in practice most inclined to pant. Thirdly, the trouble has in some vessels been found in the 'tween decks and not below the lowest deck, where the framing surely would pant, if it were going to pant anywhere. Even supposing the trouble was due to panting it would still be more rational to increase the rivet power in preference to adding to the dimensions of the framing. The latter action ought only to be taken when the framing itself is found to give trouble. I think it is well to consider each of the various causes of trouble separately. With regard to the landing edges, the shearing stresses are the important ones. On the other hand, trouble may of course occur, and does occur, which is due to panting. If the framing itself is weak, it will bend, and the bending will usually show itself by the rivets getting loose at the beam knees and at the floor end attachments. If such be the case, then the framing ought to be increased. The weakness of a girder need not necessarily show itself by excessive deflexions. Its stiffness may be sufficient, but its rivet attachments may not be in proportion thereto. If, therefore, as has happened, the rivets attaching the frames to the shell plating get loose, it may be said to be due to panting, but the remedy ought to be the closer spacing of the rivets in the frames or the doubling of the frames. These stresses on the frame rivets are getting larger with the tendency to build very deep ships, where the framing is being increased without a propor-

tionate increase in the rivet attachment. These stresses will also, where the framing is of equal strength in proportion to the span, be greatest where the span is least. They will, therefore, be of importance, particularly in deep vessels, say, with three tiers of beams and comparatively small frames, and there can be no doubt that the growing practice of fitting double frames in the deep holds in vessels of this type is a wise one.

Where vessels are of a depth to require some additional transverse strength, but not of sufficient depth to require a tier of beams, the framing is sometimes made up of channels with a reversed angle, as indicated by Fig. 2_B (Plate XXI.). This arrangement is very efficient, in so far as it provides the strength where it is required, and saves the extra weight in the 'tween decks, but it has a much greater tendency to strain the rivets attaching the frames to the shell plating than the arrangement where the strength is obtained by means of greater depth of framing as indicated by Fig. 3_B (Plate XXI.). The extra reversed frame may also have to be resorted to in very deep vessels, where specially strong framing has to be provided. It is, therefore, important in such cases to see that the shell riveting is sufficient. If the frames are not to be doubled the rivet power for a given frame spacing can only be increased by reducing the spacing of the rivets. This will, however, reduce the efficiency of the shell plating, and it follows that the necessity of providing sufficient rivet attachment of the frames to the shell practically places a limit to the frame spacing in large vessels.

The stresses on the attachments to the shell plating will naturally be considerably concentrated at web frames, and it is, therefore, desirable to give these a double attachment to the shell plating in large vessels, say, where they are fitted to compensate for a tier of orlop beams.

Dealing with the whole question of riveting it is impossible to determine the exact strength required in each case. On the other hand, if we base our investigations on experience gained by other vessels, I do not think it is so very difficult to form a reasonably correct idea as to the places where the limit of safety is being approached with the gradual modifications in the construction, loading and ballasting of ships, and where trouble may therefore eventually be expected to occur. Many, however, often

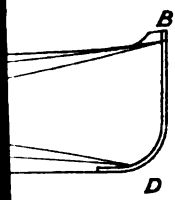
have difficulty in believing that there is any danger until ac straining does take place. I think, therefore, it is highly s factory to find Mr. Hogg alive to the importance of making vestigations before failure necessitates attention to be give the subject.

Yours faithfully,

J. BRUHN.

The discussion was adjourned.

The meeting then dissolved.



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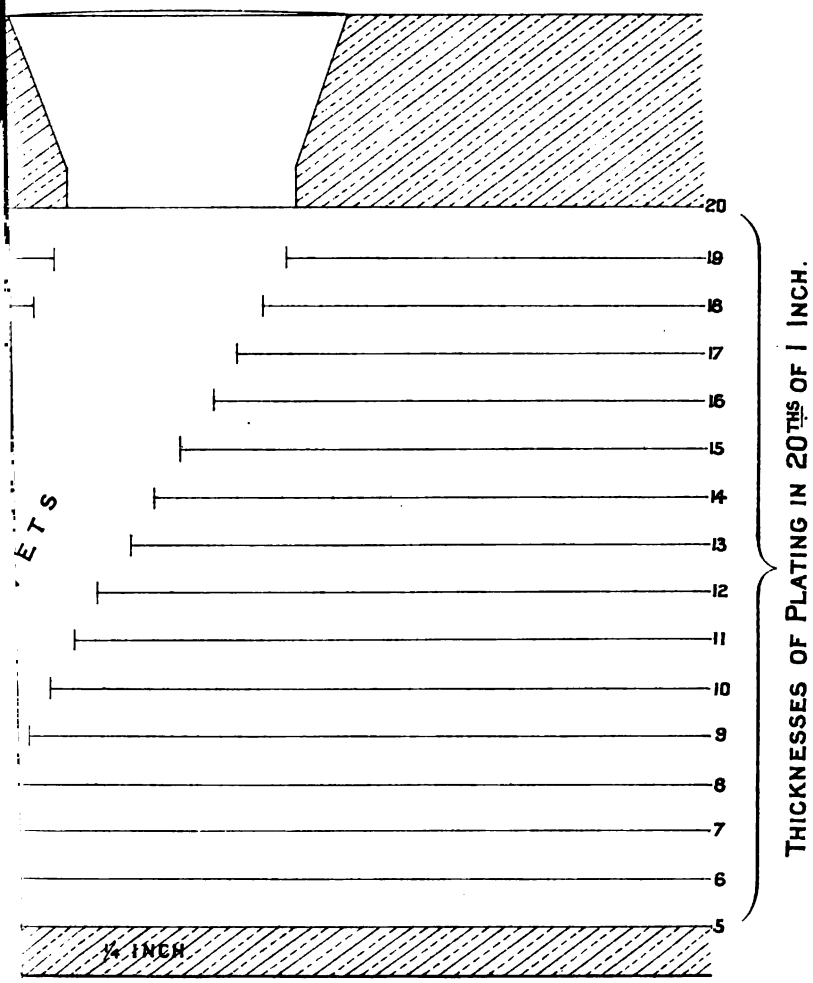

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To illustrate Mr. J. Bruhn's Remarks on Mr. A. Hogg's Paper on "Some Points in the Construction of Large Ships."

FIG. 1B.

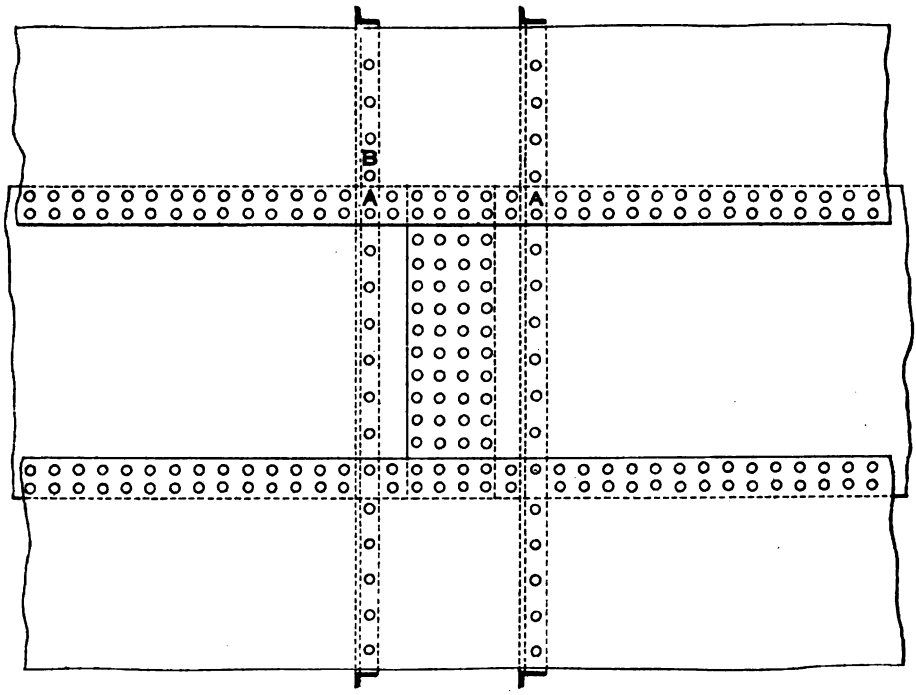


FIG. 2B.

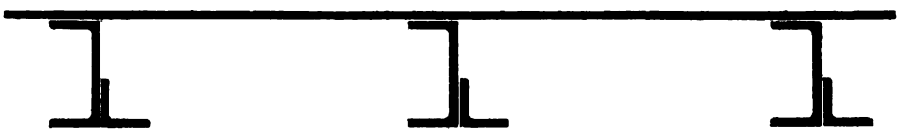
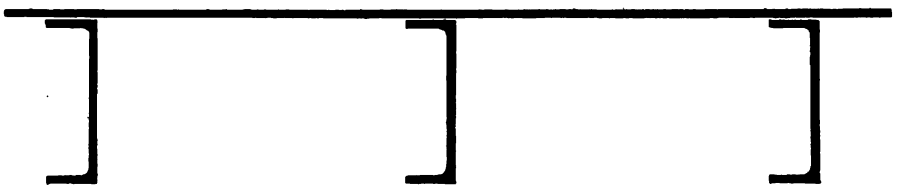


FIG. 3B.



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Vol. XIX. SESSION 1902-1903. Parts 8 & 9.

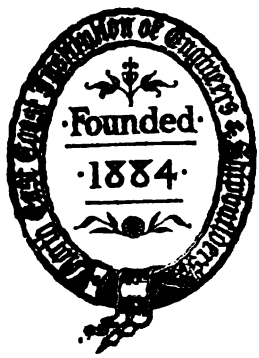
TRANSACTIONS

OF THE

NORTH-EAST COAST INSTITUTION

OF

Engineers & Shipbuilders.



CLOSING BUSINESS MEETING, MAY 22ND, 1903.

MR. J. DENHOLM YOUNG'S REPLY TO THE DISCUSSION ON HIS PAPER ON "LOSS OF POWER IN STEAMSHIP VIBRATIONS."

RESUMED DISCUSSION ON MR. F. H. ALEXANDER'S PAPER ON "A DISPLACEMENT TABLE FOR USE WITH THE TCHEBYCHEFF FORMULA."

RESUMED DISCUSSION ON MR. ARCHIBALD HOGG'S PAPER ON "SOME POINTS IN THE CONSTRUCTION OF LARGE STEEL STEAMERS AND THE RIVETING OF LAPPED BUTTS," AND MR. HOGG'S REPLY.

REMARKS ON "EDUCATION IN TECHNICAL SCIENCE AND GENERAL TRAINING OF YOUTHS." BY MR. JOHN TWEEDY.

MEMOIRS.

TITLE, CONTENTS, LIST OF MEMBERS.

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This Part completes Vol. XIX.

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NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.

NINETEENTH SESSION, 1902-1903.

PROCEEDINGS.

CLOSING BUSINESS MEETING OF THE SESSION, HELD IN THE LECTURE HALL OF THE LITERARY AND PHILOSOPHICAL SOCIETY, WESTGATE ROAD, NEWCASTLE-UPON-TYNE, ON FRIDAY EVENING, MAY 22ND, 1903.

JOHN TWEEDY, ESQ., J.P., PRESIDENT, IN THE CHAIR.

The SECRETARY read the minutes of the last General Meeting held at Sunderland on Thursday, April 23rd, 1903, which were confirmed by the members present and signed by the President.

The President appointed Mr. R. H. Muir and Mr. G. D. Wear to examine the voting papers for new members, and the following gentlemen were declared elected:—

MEMBERS.

Blackett, Jos. S., Engineer, c/o Messrs. Smith's Dock Co., Ltd., North Shields.
Dowsen, Jas. Wm., E. Draughtsman, 21, Croft Terrace, Jarrow-on-Tyne.
Elliott, Andrew, Engineer, 27, Church Road, Seaforth, near Liverpool.
Garwood, Harry Tom, Engineer, Lieut, R.N., 36, Hawthorn Street, Newcastle upon-Tyne.
Ions, Thomas Robson, Engineer, 11, Newcastle Street, North Shields.
Leach, Thos. A. Wm., Supt. Engineer, 14, Rue du Bastion, Antwerp.
McNab, Andrew P. W., Ship Surveyor, Lloyd's Registry of Shipping, Collingwood Buildings, Newcastle-upon-Tyne.
Morgan, Wm. Geo., Shipbuilder, 10, Rue du Bastion, Antwerp.

GRADUATE TO MEMBER.

Taylor, J. T. Lloyd, Civil Engineer, Dock Engineer's Office, Middleton Road, West Hartlepool.

GRADUATE.

Bolton, Frank, Ship Draughtsman, Beaconsfield Square, Hartlepool.

AWARDS TO GRADUATES.

The PRESIDENT announced the following awards to graduates for papers read before that section during the Eighteenth Session.

Books, etc., to the value of £3 to Mr. George Robson for his paper on "Superheated Steam and Superheaters."

Books, etc., to the value of £2 10s. to Mr. N. H. Temperley for his paper on "The Application of Electric Power to the Driving of Factories."

Books, etc., to the value of £1 10s. to Mr. A. W. Bowerbank for his paper on "The Auxiliary Machinery of Ships."

Mr. J. DENHOLM YOUNG replied to the discussion on his paper on "Loss of Power in Steamship Vibrations."

The discussion on Mr. F. H. Alexander's paper on "A Displacement Table for Use with the Tchebycheff Formula" was closed.

The discussion on Mr. Archibald Hogg's paper on "Some Points in the Construction of Large Steel Steamers and the Riveting of Lapped Butts" was resumed and closed.

Closing Business of the Session.

MR. J. DENHOLM YOUNG'S REPLY TO THE DISCUSSION ON HIS PAPER ON "LOSS OF POWER IN STEAMSHIP VIBRATIONS."

LIVERPOOL,
May 20th, 1903.

DEAR MR. DUCKITT,

I very much regret that I shall not be able to be present at the Closing Meeting of the Institution on 22nd inst., but I must express my thanks to the President, also to Mr. Withy, Mr. Morison and Mr. Fothergill for the kind reception they have given to this very incomplete and hurriedly prepared paper. We are all well acquainted with our President's successful efforts, in conjunction with Mr. Yarrow and Mr. Schlick, to reduce the vibration of steamships, and of the great benefit derived from the Yarrow-Schlick-Tweedy system, especially in high-speed engines.

Such vibrations as are caused by the propeller I doubt if it will ever be possible entirely to eliminate, owing to the difference in the speed of the upper and lower strata of the wake in which the propeller works, as well as the differences in fluid pressure apart from wake.

Capt. Baker's observations of his experience regarding the effect of different cargoes on vibration are valuable, and raise an interesting point, namely the effect on speed of elasticity in a vessel and its cargo.

The effect of springiness in a ship in passing over waves may be likened, within reasonable limits, to the qualities of a spring cart or a pneumatic tyre in passing over the roughness of a road, —resistance to motion is diminished and the development of speed assisted.

In the old days of sailing ships it was known that carrying the ballast on top of a springy substance was better for speed than letting it lie against the boards.

These considerations, however, arise only with regard to motion communicated from the waves to the ship, and it is quite likely that with a springy cargo such as Captain Baker indicates there

is a sensible increase in the speed of a vessel as compared with a non-springy one.

The reverse is the case, however, when we come to consider the vibrations caused by the power which is intended for driving the ship. However springy the ship may be, it would evidently be better that the machinery should be such as to communicate no vibrations to the hull and cargo. The question evidently is not, whether it is better for a vessel to have springiness, but whether it is better to have an engine that will not cause even a springy ship and cargo to vibrate.

I am much indebted to Admiral Melville for his valuable remarks, and am glad to find that working along a totally different line of reasoning he has come to practically the same conclusion, namely that the actual loss of horsepower occasioned by vibration is a very small one.

In his papers in *Engineering*, he allows for the possibility of a much larger co-efficient of viscosity in the structure of a ship than has been found by experiment on steel wires. I think that there is every probability of this being the case, although conclusive experiments on a sufficiently large scale are difficult to make.

To avoid the difficulty of these experiments, it will be seen that I have treated the losses *en masse*, as it were—fluid and solid together, instead of analytically.

I am indebted to Mr. J. H. Irwin for revising the proof of the paper and for reminding me of the curious phenomenon in connection with air-pulsation in funnels.

Again thanking the President and members for the kindly reception they have given to this paper,

Yours faithfully,

J. DENHOLM YOUNG.

P.S.—Since the last meeting, it has been pointed out to me by Mr. George Sisson, of Messrs. The Washington Chemical Company, that in the case of Crookes' radiometer, it is now understood that the vibrations of light are not directly but indirectly transformed into mechanical energy, through the heating of the particles of highly rarified air in the apparatus on one side of the vanes.

J. D. Y.

The PRESIDENT said—We are much obliged to Mr. Young. In Sunderland a hearty vote of thanks was accorded to Mr. Young for his excellent work. I am sure this Newcastle meeting wishes to take the opportunity of endorsing that vote of thanks, and I propose that we conclude the discussion on Mr. Young's paper, and his reply to that discussion, by a vote of thanks to him.

The proposal was carried by hearty acclamation.

RESUMED DISCUSSION ON MR. F. H. ALEXANDER'S PAPER ON "A DISPLACEMENT TABLE FOR USE WITH THE TCHEBYCHEFF FORMULA."

The PRESIDENT said—A letter has been received from Mr. Alexander and unfortunately, through ill-health, he is unable to be present to-night.

The SECRETARY said—It appears from Mr. Alexander's letter that so far as his reply is concerned it will have to be sent later, for publication in the *Transactions*.*

The PRESIDENT said—I am sure that Mr. Alexander certainly deserves a very hearty vote of thanks, and I suggest that the Secretary be requested to convey the thanks of this meeting to him for his good work in preparing this paper. Mr. Alexander is not an old member of this Institution; he is not an old inhabitant of this district and it is a great pleasure to us all to find a new member occupying his time in providing us with such interesting matter.

The vote of thanks was carried by hearty acclamation.

The SECRETARY said—I may say that in the letter Mr. Alexander has sent to me he has promised to give us another paper next Session, but upon what subject I do not, at present, know.

* The Secretary regrets to state that, up to the time of printing, owing to the continued illness of Mr. Alexander, the reply to the discussion on his paper has not been received.

RESUMED DISCUSSION ON MR. ARCHIBALD HOGG'S PAPER ON "SOME POINTS IN THE CONSTRUCTION OF LARGE STEEL STEAMERS AND THE RIVETING OF LAPPED BUTTS."

Mr. H. M. Macmillan said—I have listened with a good deal of pleasure to Mr. Hogg's paper on this subject: a subject, I suppose, that nearly everyone interested in naval architecture, since iron and steel ships have been built, has either written about or studied: and yet we have still a great deal to learn about it, and our knowledge is, to a considerable extent, the result of sometimes painful experience.

Mr. Hogg has some rather pronounced opinions on the subject and he does not hesitate to give us precise figures to tilt against. He begins his paper by considering the pressure on a ship's bottom, caused by a wave the crest of which is 40 feet above the vessel's keel at any point, as being that due to a hydrostatic head of 40 feet at that point; as a matter of fact it is something considerably less, since a correction has to be made for the distance that the centres of the orbits of the particles in the wave crest have been moved above their mean still-water position, which gives a buoyancy and therefore pressure less than is indicated by the wave profile for the parts immersed in the upper half of the wave.

Mr. Hogg puts, I think, somewhat unnecessary emphasis on the item of iron rivets in making a deduction for them of about 5 per cent. on the strength of the section due to the difference in safe tensile stress between iron and steel. While he does not actually say that iron rivets are inferior to steel, I think the fact that a comparative correction of this small amount is made for that item justifies the impression that were steel rivets introduced such a deduction would not appear. I personally think that iron rivets are certainly preferable to steel where great scantlings have to be worked by hand with rivets of large diameter, and this is exactly the case under consideration; for steel to be soft enough must be hotter than iron, and there is consequently considerable danger of the former getting burnt

and being therefore less efficient than iron over any complete section.

When a ship is rolling or pitching among waves she does not maintain her statical position vertically in them: it has been proved that a vessel may be driven, when on the crest of a wave, as much as 8 or 9 feet above the position due to equilibrium between her weight and buoyancy, causing as much as from 5 to perhaps 12 per cent. reduction in her hogging moment, as we estimate it: and in the same way, due to her inertia and the addition of the force of gravity causing the vessel to plunge far below her position of statical equilibrium when in the wave hollow, her sagging moment may be increased over 20 per cent. above our estimated figures. Again, we assume that the hogging and sagging moments on a vessel induce stresses amidships, as in a beam, due to simple bending, but this clearly is sometimes far from being the case, due to the vessel's shape, her inclinations in the wave, the imperfection of her connections absorbing some of the energy, the behaviour of her structure under alternating forces and several other considerations, so that I think it is almost futile to attempt to analyse minutely, and to apportion their exact value in an absolute way, some of the items which the author has considered, when more important considerations modifying the result, many of which it is probably impossible to correctly estimate by any process of calculation, are ignored. The stresses we derive are principally useful for comparative purposes, and as a rule may be taken to be considerably in excess of those likely to be met with, as we assume the worst possible conditions for the ship, and ignore as a rule, all local items of strengthening in calculating the principal stresses, though these must often contribute somewhat to the resistance to straining.

A good deal of attention has been paid of late to the somewhat difficult question of the stresses brought about by sheering forces: the maximum sheering forces that occur towards the ends of vessels. Mr. Hogg discusses this feature, and it is likely that from some points of view his scheme of modified butt riveting, with wider spaced rivets in the two outer rows of overlapped butts, gives more uniformity of strength over the connection than the usual method; yet the practical difficulty often found in getting sufficient rivets into the butt connections of large vessels, may probably counterbalance this advantage, unless

wider overlaps be fitted, a thing sometimes almost impossible to do without increasing the frame spacing. The arrangement of these tables is, however, very ingenious and deserves our careful attention.

I think Mr. Hogg underestimates the sheer stress in taking it at 2 tons per square inch in a large full ship (and I am assuming that the vessel is of such a length as to be put on a wave of the height he has mentioned: that is, from 450 to 500 feet long). The resultant maximum stress forward and aft on the rivets of the plate landings will be a great deal more than this, I estimate about 5 tons an inch or possibly more; and to resist such stresses I cannot think Mr. Hogg's proposal to increase the scantlings of the frames here is the best that could be suggested, or that it would cure an evil the very existence of which his figures show Mr. Hogg does not appear to think is a very real one. Those items of the ship which must take up this sheer do not principally include the frames—except the flange on the shell, which might advantageously be increased, to get reeled or closer spaced shell rivetting—and the forces must be taken up by something other than these. According to Lloyds' new rules the landings of the shell in the vicinity of the neutral axis ought to be increased, at about $\frac{1}{4}$ of the length from each end, for this reason. While I think this is certainly the best way in which to meet the case, I do not think that Lloyds are quite justified in increasing the landings at both ends equally; the sheering stresses are likely in full ships to be greater forward than aft, as there is for one thing a greater girth of material forward, and if treble riveted landings are needed here in full ships above 480 feet long, aft they might not be insisted on till the ships are considerably longer.

Mr. Hogg brings under our notice a number of things on this important subject, in a very interesting way, and whilst I cannot agree with some of the conclusions to which he has arrived, I think the thanks of the Institution are due to him for his paper, and the amount of work which such an investigation as this always entails.

MR. A. HOGG'S REPLY.

Mr. Hogg, in reply, said—I thank Mr. Bruhn for his letter, which I have read with great interest. I am pleased to get his approval of the importance of the points raised in my paper.

Regarding the butt riveting, I draw attention to a sentence in Mr. Bruhn's letter, viz.: "The facts are briefly that we have had a considerable amount of experience with butt riveting, particularly at the top side plating amidships, and we know that the attachments at this place are not much in excess of what is necessary to meet the stresses thrown upon them." The riveting introduced in my paper will increase the strength of the butt fastenings. This will relieve the adjoining strakes of so much work, thus adding to the general strength of the ship. I am pleased that Mr. Bruhn considers it recommendable. He seems, however, to have missed the last column in the rivet table, which if carried out entirely would increase the number of rivets a little more than the present rules generally require. I give below another table with the rivet spacings arranged to give the rivet area about 94 per cent. of the strength of the solid plate. This table, I imagine, fully meets Mr. Bruhn's idea. I would suggest that this table be used in the midship portion and top and bottom of the ship, while the others, arranged for tension only, might be adopted in the remaining portion of the ship.

TABLE No. III.

Thickness of Plate in 20ths of an Inch.	Diameter of Rivets	No. of Rows of Rivets.	Spacing in Inches centre to centre. One outside row on each side of Lap.	Inside Rows.
5	$\frac{5}{8}$	2	$2\frac{1}{2}$	—
6	$\frac{3}{4}$	2	3	—
7	$\frac{3}{4}$	3	3	3
8	$\frac{3}{4}$	3	$3\frac{1}{2}$	$2\frac{1}{4}$
9	$\frac{7}{8}$	3	4	$2\frac{3}{4}$
10	$\frac{7}{8}$	4	$4\frac{1}{4}$	$3\frac{1}{2}$
11	$\frac{7}{8}$	4	$4\frac{1}{2}$	3
12	$\frac{7}{8}$	4	$4\frac{3}{4}$	$2\frac{3}{4}$
13	1	4	5	$3\frac{1}{4}$
14	$1\frac{1}{8}$	4	$5\frac{1}{2}$	$3\frac{3}{4}$
15	$1\frac{1}{8}$	4	$5\frac{1}{2}$	$3\frac{1}{4}$
16	$1\frac{1}{8}$	4	$5\frac{3}{4}$	$3\frac{1}{2}$
17	$1\frac{1}{8}$	5	6	4
18	$1\frac{1}{8}$	5	$6\frac{1}{4}$	4
19	$1\frac{1}{8}$	5	$6\frac{1}{2}$	$3\frac{3}{4}$
20	$1\frac{1}{8}$	5	$6\frac{3}{4}$	$3\frac{3}{4}$

Mr. Bruhn says, "Lap butts do not form an ideal attachment in the case of the thicker plates which are called upon to do their full amount of work in direct tension or compression." I think, from the experience gained in figuring up these butt tables, that the limit thickness of the full efficient attachment

is 18/20." Above this the rivet area is not quite up to the standard for the compression butts.

I would like to say a word about "thicker plates which are called upon to do their full amount of work." A mistake is made in believing that it is only the topmost plates, such as sheerstrakes, stringer-plates, etc., which are called upon to do their full amount of work. All plates in the top, bottom and sides of the ship, which have been included in the "moment of inertia" calculation, are doing their full amount of work and should have the full butt connection; otherwise they should not be included, and a corresponding reduction should be made.

As regards the safe working stress, a good way to show the inconsistency of the present comparative system will be to give an example. Two steamers each 400 feet long, same beam and depth, steamer "A" with a coefficient of fineness of ·67 and a displacement of 9,600 tons, and steamer "B" with a coefficient of ·80 and 11,400 tons displacement. The maximum bending moment for "A" is 10,970, and "B" 13,030, using the formula "displacement multiplied by the length and divided by 35." Taking steamer "A" first, and assuming a stress of 8 tons per square inch at 20 feet, the greatest distance from the neutral axis, the moment of inertia becomes 27,450. Then for steamer "B," using the same moment of inertia, because the scantlings are the same, the stress per square inch works out at 9½ tons; so that for vessels of 400 feet length we have a range of stresses. Unfortunately the stress is greatest with the heaviest ship: where we have the stresses becoming so great and increasing with the size and fulness of form of the steamers, the inclination is to make a tin ship. I cannot believe that the usual method of finding stresses by assuming a steamer to be "rested" on a wave of her own length, etc., is an exaggeration, when we know what a rough tossing they get at sea, and we have no right to say the stresses "may" be less. When we find a steamer, built to the highest class in Lloyds, coming home with a large number of plates in the bottom, at or near midships, actually fractured, it does not follow that it is because the butt fastenings throw extra work on the next strakes. No doubt the plate adjoining a butt does get more work, but that has been and will always be the case, and if so many plates fracture in one ship, is not that ship weak? And does not

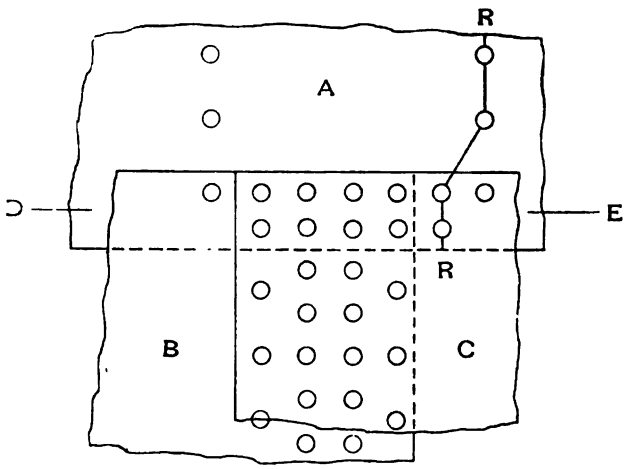
that show the necessity of modifying the present comparative stresses, at least to suit the large full-formed steamers? Is not this experience proving that the corresponding scantlings are insufficient? The scantlings can be insufficient even if actual fracturing does not take place. Are the scantlings only to be increased gradually at such parts as experience shows clearly are weak? The science in designing scantlings for large full-formed steamers seems to aim at making the ship just strong enough to prevent her showing signs of straining. The last sentence but one in Mr. Bruhn's letter is worth repeating, viz.: "Many, however, often have difficulty in believing that there is any danger until actual straining does take place." Mr. Bruhn apparently has no difficulty in believing that there is a danger of ships straining too much.

Regarding the loss of strength due to iron rivets, if the rivet does not fill the hole this would cause a loss right away. Again, rivets are already doing a very large work in drawing the plates up to the frames, so that it is perhaps doubtful if the loss is not greater than stated by me in my paper.

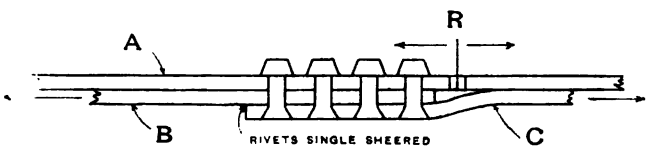
Mr. Bruhn calculates that the stress on the bottom plating at a draft of 40 feet should be $4\frac{3}{4}$ tons per square inch; he does not say what percentage of loss that is equivalent to. I figure it at 30 per cent. at this part of the ship, whereas I gave it as, roundly, 20 per cent. all over the lower half of the steamer. In a case where the plating is of just the thickness necessary to stand the hydrostatic pressure the loss will be 50 per cent. at that part. Mr. Bruhn, in making his calculation, took the plating as a fixed ended beam; I took it as a continuous supported one, when the greatest B.M. is at the frame line and where the section is reduced by the rivet holes; but of course the weakest part would only be at about midway between two fore and aft intercostals. The modified wave pressure should not affect the calculation because the heave and fall of the steamer will more than balance it.

Mr. Bruhn says: "With the usual arrangement of lap butts the after ends of plates of an outside strake are not usually quite so well attached as the fore end, as the latter gets the advantage of having the butt rivets in the landing edges in double sheer." This is a common error. These rivets are not in double sheer, and both the ends are alike. Referring to

the diagram below: The plate A of the inside strake of plating, adjoining the butt of the two plates B and C of the next strake, is doing its own work and more, at this part, on account of its vicinity to the butt, and it would easily break at the line RR, near the back row of rivets in the butt, when the part which is riveted to B plate would move along with B plate, so that this plate of the inside strake would not sheer the rivets in the



SIDE ELEVATION.



PLAN THROUGH D.E.

butt of the outside strake. And Mr. Bruhn cannot say as he does, viz.: "As a matter of fact all the fractures in the above case agreed with this view." Each longitudinal plate or bar ought to have its butts fully connected, independent of the adjoining plates.

The seam riveting at the ends of the steamer is a point which is really not part of the main subject of my paper. I was led to mention it, having heard of a large full-formed steamer

which was in dock with a large number of fractured plates and loose seam riveting on the flat of the bottom near amidships, while the end seams were intact. This vessel had good framing on the sides, stronger than the usual cargo steamer. If the frame bends slightly it may do so without showing any looseness at the beam or at the floor, but there would be considerable stress on the shell plating. I do not think the very end of the steamer a place where panting would show, because this part is usually well stayed with panting beams, which are beams fitted with the special object of preventing panting.

Mr. Bruhn's remarks on the frame attachment to the shell plating are instructive and should be carefully read, as they show the importance of the part they play in this portion of the ship's structure.

I also thank Mr. Macmillan for his criticism. The fact that a vessel may be driven 8 or 9 feet above the position due to equilibrium between weight and buoyancy is sufficient to support me in taking the full water pressure when assuming the ship to be rested on a 40 feet wave.

Mr. Macmillan shows that if steel rivets are used a greater reduction should be made than is done in the case of iron rivets.

The increasing of the frames is not proposed with the view of resisting the sheering stresses, but to relieve the plating from stresses due to the bending of the frame. My idea is also to increase the strength of the ship as a girder at these parts by increasing the butt connections, thus allowing more of the plating to be available for the sheering forces.

On the proposal of the President a very cordial vote of thanks was passed by acclamation to Mr. Hogg for his paper.

CLOSING BUSINESS.

PROPOSED AMENDED SUPPLEMENTARY BYE-LAW, No. XI.

The PRESIDENT, on behalf of the Council, gave notice at the last General Meeting that at the Closing Meeting he would move that the Supplementary Bye-Law, No. XI., relating to the Graduate Section be rescinded, and the following inserted in its place:—

"Each paper read before the Section should not exceed ten octavo pages of letterpress, and the illustrations not greater in extent than will cover two quarto plates. All manuscripts to be written on one side of the paper only, and be signed by the author. The date on which the paper was read must be inserted after its title.

At the end of each Session a Special General Meeting of the Graduates shall be convened at seven days' notice to adjudicate upon the merits of the papers read during that Session. The selection of the three best papers shall be made by ballot, and those papers marked first, second and third in degree of merit shall be placed in the hands of the Secretary of the Institution, not later than the 31st of May in each year, for the approval of the Council. These three papers will be submitted to the Reading Committee, and either one or two may be recommended to be printed as an Appendix to the current volume of the *Transactions* of the Institution; the Council reserving the right to decline to give any award, or to print any of the papers, should it consider the standard insufficient.

The submission of any paper for an award, and its publication prior to its submission to the Special General Meeting, is entirely at the option of the author of such paper; but if it be published without the sanction of the Council it shall be ineligible for competing in the Award Competition, and no reference must be made to its having been read before the Graduate Section of the Institution.

All papers submitted for awards shall become the property of the Institution, and if published in the technical journals the permission of the Council must be previously obtained and the name of the Institution must be attached."

The Council having further considered the resolution, the President, on behalf of the Council, now moved that the amended Bye-Law XI. in the following modified form be adopted:—

"XI. Each paper read before the Section should not exceed ten octavo pages of letterpress, and the illustrations not greater in extent than will cover two quarto plates. All manuscripts to be written on one side of the paper only, and to be signed by the author. The date on which the paper was read must be inserted after its title.

All papers submitted to the Reading Committee shall be placed in the hands of the Secretary of the Institution, not later than the 31st of May in each year.

Of these papers submitted to the Reading Committee either one or two may be recommended to be printed as an Appendix to the current volume of the *Transactions* of the Institution, the Council reserving the right to decline to give any award or to print any of the papers should it consider the standard insufficient.

The submission of any paper for an award, and its publication prior to its submission, is entirely at the option of the author of such paper, but if it be published without the sanction of the Council, it shall be ineligible for competing in the Award Competition, and no reference must be made to its having been read before the Graduate Section of the Institution.

All papers submitted for awards shall become the property of the Institution, and if published in the technical journals the permission of the Council must be previously obtained, and the name of the Institution must be attached."

The PRESIDENT, in doing so, said—I wish to explain that the Council in its wisdom—wisdom I hope it will turn out to be—has adopted the suggestion of the Graduates, and instead of the amendment to the rule originally submitted I beg to move that the modified bye-law be adopted. The essential difference between the two is that, instead of the Graduates deciding by ballot amongst themselves as to the three best papers, the Committee of the Council will decide. The Committee of the Council has taken upon itself a rather onerous duty. Perhaps it is better that the Graduates should be relieved from the sometimes rather personal obligation of deciding amongst themselves as to whose paper deserves to be published, and so the Council has adopted their recommendation.

Professor WEIGHTON said—I have very much pleasure in seconding the proposal.

The motion was carried, *nem. con.*

EDUCATION IN TECHNICAL SCIENCE AND GENERAL TRAINING OF YOUTHS.

The PRESIDENT, on behalf of the Council, moved the following resolution:—

> "That an Educational Committee of this Institution be formed to consider questions which may arise in regard to the education in Technical Science and general training of Youths entered or preparing to enter Engineering and Shipbuilding Works; to discuss such questions with public and other educational bodies, and to advise upon them. The Committee to have powers to add to its numbers, and to associate itself by sub-committee or otherwise as may be arranged with similar Committees of kindred Institutions."

The following gentlemen have been nominated by the Council to act on the Committee: Mr. John Tweedy, Mr. Robert Thompson, Mr. Henry Withy, Mr. W. H. Dugdale, Mr. G. B. Hunter, Mr. Summers Hunter, Mr. D. B. Morison, Prof. R. L. Weighton, Mr. Henry Clark, Mr. Frank T. Marshall.

In moving the resolution I ought perhaps to explain that strenuous efforts are being made, especially in the south, to secure greater efficiency in the education and training of engineers, shipbuilders and others engaged in industries which require a scientific education. It is thought that the practical experience of the members of such Institutions as this is, if applied to the consideration of the subject, ought to be of immense value to educational authorities.

I ventured in October last to suggest that we are not keeping in line with some other countries, especially in the study of the higher branches of technical science. Recent papers by Professor Dalby, who, at the instigation of my friend, Mr. Yarrow, has spent some months abroad in an exhaustive study of the subject, confirms that view. Besides America, where Professor Dalby spent some weeks in enquiring into the whole question, he has studied the educational machinery of Germany and Switzerland. Mr. Morison, whom I am glad to see here, has also just been in Switzerland and has returned fully satisfied that a change must be made.

Professor Dalby, for example, finds that while in the United Kingdom only 3,370 students attend the higher courses in technical science, 10,740 attend in Germany, and 13,465 in the United States of America.

I attended a meeting in London a few days ago to consider this subject. The result of that meeting will be, I hope, the organization of a Joint Committee of the leading Institutions of this country for the purpose of determining how best to raise the standard of training in engineering in all its branches, and you will notice that in the resolution I have the honour and pleasure to propose provision is made for the Committee of this Institution becoming associated with the proposed General Council or Committee of the country.

In America, properly qualified youths do not pay a premium to enter works, but on the contrary receive higher wages as a pupil because of their higher educational qualifications. In this way, while maintaining the essential condition that a certain number of youths entering their works shall possess the highest qualifications, the sons of poor men, who possess the engineering instinct, the necessary ability, character and the grit to surmount the initial disadvantage of an irregular training in scientific studies, are encouraged, equally with the rich man's sons, to carry on their studies. They know that as soon as they are able to comply with the conditions of entry they will be allowed to apply their acquirements to useful purposes without first having to pay a premium.

It is very clear from Professor Dalby's reports that the general question of higher education in science of the United Kingdom depends very largely upon the attitude assumed by employers. It is thought that if employers would take some definite action which would indicate, to parents and guardians and to the public, that they appreciated the advantages of having in their employment young men whose education has been properly directed and who possess the instinct for engineering or shipbuilding, as the case may be, and who have energy, and ability and ambition enough to study hard and acquire a thorough knowledge of science—if we, as employers, will indicate to the public that these young men will receive some sort of encouragement; that instead of being asked to pay a premium we shall be only too pleased to pay them higher wages, colleges and universities would very soon arrange their courses to suit the demand which action of that kind would certainly induce. Such encouragement is now being offered by some employers in this country. My own firm, Messrs. Wigham-

Richardson & Co., has decided to make a start. Mr. Yarrow. in London, has already opened his works without any premium whatever. He is a man of great reputation. His work is of the highest class, and yet he has opened his works to young men without any payment whatever. We now propose in Walker—Mr. Morison, Mr. Summers Hunter and others, too, have some such scheme under consideration—to introduce changes which it is hoped will secure the services of a few men who possess the highest scientific training it is possible to acquire in this country. At Walker, therefore, we have practically decided to adopt the following regulations:—

A. Youths who have passed through a three or four years' engineering day course at an approved technical science college or university, and who have obtained either an approved certificate or a pass degree in engineering or naval architecture, may be admitted into the works as pupils. They will serve a three years' pupilage, one year being spent in the drawing office. The scale of pay will be 8s., 15s., and 20s. per week in each year.

Those who hold the degree with honours, or a certificate of the first class, may be admitted on the same conditions as the above, but will receive 5s. per week more pay.

B. Youths who hold no approved college degree or certificate may be admitted into the works as pupils, on the production of a certificate showing that they have passed the matriculation examination required for graduation in engineering science, at an approved science college or university, or a certificate showing they have passed an approved equivalent examination.

Their pay for the first year in the works will be that of ordinary "apprentices." They must give an undertaking that they will attend, for at least three academical years, the degree course, or an approved certificate course, of study at an approved college or university during the currency of their pupilage, which will extend over a minimum period of five years, including the time spent at college. One year will be spent in the drawing office, and the scale of pay, while in the works, will rise gradually to equal that under scheme "A" in the last year.

C. Sons of workmen and other employees who have entered the works as ordinary "apprentices," and who by their energy and abilities succeed during their apprenticeship in qualifying themselves for transference to the rank of pupils, by passing the matriculation or equivalent examination prescribed under scheme "B," will be treated, for the remainder of their time, as pupils under scheme "B," in respect of leave to attend college day classes, promotion, and rate of pay. It is understood that in every case the advancement of an "apprentice" to "pupil" rank in the works or office is absolutely at the option of the firm, and promotion will depend solely upon the merit, deserts, and qualifications of the individual apprentice, and the business requirements of the firm.

The age of pupils at entry under scheme "B" should be from 17 to 18 years.

NOTE.—In these regulations the term "apprentice" is understood to refer to those who enter the works to learn one or more of the trades or handicrafts therein practised, who serve the usual five years' apprenticeship in the works, who may or may not attend evening science classes, but who do attend a systematic college day course of instruction during their apprenticeship, and whose object is to qualify as mechanics or artizans.

The term "pupil" is, on the other hand, understood to refer exclusively to those who enter works not with the sole view of becoming expert in any handicraft, but with the view of ultimately rising into the higher branches of the profession of engineering or shipbuilding, *e.g.*, draughtsmen, managers, superintendents, inspectors, consulting experts, or employers; who may or may not attend evening science classes, but who either have already attended or will attend, a systematic course of instruction at University college day classes.

The foregoing regulations deal with the "pupil" class alone, and do not disturb any existing rules which are in force at present in these works regarding "apprentices."

I understand, the President went on to say, that several other employers view very favourably the proposal that encouragement should be given to young men who make definite efforts to acquire knowledge in the branches of science which are useful in their business. But it is held by some that there are plenty of men in the country who would willingly pay a premium for the privilege of their sons entering the works. That may be, but, on the other hand, there are plenty of brilliant young men who have succeeded in excelling other men in proficiency, who are unable to pay a premium, and I think it would be very short-sighted policy to shut out from our works, for the sake of a few pounds in premiums, picked men who are born engineers or shipbuilders. A committee such as is proposed is urgently needed to consider and advise on such questions, and I therefore have very great pleasure in proposing that the resolution I have just read should be adopted by this meeting. I think the effect of the appointment of such a Committee will be good. I hope to find presently a Joint Committee or Council upon which all the important Institutions in the country will have representatives. That Council, we hope, will succeed in influencing the colleges and universities. I do not know whether they are ambitious enough to tackle Cambridge and Oxford; perhaps they are. At all events they intend to let it be known exactly what is the kind of training engineers and technical people require, and to use their influence to bring about changes in the curriculum of schools and colleges.

Mr. EDWIN GRIFFITH said—I have much pleasure in seconding the resolution which the President has proposed, and I should like to say a few words on its purely educational aspects. We are all aware that one of the chief objects of the Education Act of last Session was to constitute better means of providing secondary education in this country. It was rendered necessary by the decision in the Law Courts that the School Boards were exceeding their powers by endeavouring to provide that kind of education to the best of their ability. Of course, other questions arose when the scheme came to be developed, and most of the public discussion in Parliament and elsewhere did not turn so much on the educational merits of the Act as on other matters. The fact that the primary object of the formation of these educational authorities was to provide a better system of secondary education is, I think, a very important one for us, because in this district—in the north-eastern districts generally—secondary education will be largely associated with technical instruction. By this, I mean the sort of education that all of us ought to have had, and which we wish those who come after us to enjoy. Judged from this point of view I think you will conclude that the committees that are being formed to administer the Act will be none the worse of having some assistance and advice from those better acquainted than they are with the actual requirements, and I do not know in this district any authority so capable of tendering such help as this Institution of engineers and shipbuilders. Not only that, but it is our absolute duty to take some such action in the matter; because if we leave the educational authorities to do their best according to their lights the chances are that their best will be bad, and the consequences unsatisfactory. Should this course be followed technical people will be justly charged by public opinion with having stood idly by and done nothing to keep things straight, except criticise when too late. We ought to guard ourselves now against being liable to that charge later on, by taking some definite step to let organised engineering opinion be impressed on the public authorities, and I see no better way of doing this than by appointing such a committee as this resolution proposes. Therefore I have great pleasure in seconding the resolution, and I hope our Committee will soon have an opportunity of joining with similar committees of

kindred Institutions, so as to make the movement national instead of merely local.

Mr. D. B. Morison—We are all greatly indebted to our President for his masterly review of the question of technical education in his presidential address, and for the proposals he now puts before us, as they represent a great advance towards effecting a practical solution of this most important problem. Having recently visited the principal manufacturing centres in Germany and Switzerland, I was once again greatly impressed with the high standard of technical education which prevails—its evident effect on all the leading industries, and especially on those with which members of this Institution are associated. An object lesson was afforded by the Dusseldorf Exhibition, where the excellence of design and manufacture was strikingly apparent. This remarkable progress is undoubtedly due to the high standard of technical training which has been so actively and ably promoted in Germany during the last decade, and if we in this country are to maintain our position, it is imperative that our standard of technical education should be raised. Our President (Mr. Tweedy) has with great persistence and ability brought this question to a successful point, and it now remains for us to follow his advice and example so that his term of office may be identified with a new era on the north-east coast.

Professor R. L. Weighton said—I am very glad indeed to have the opportunity of endorsing what has been so fitly said by Mr. Morison. The credit for the agitation, or movement, which is first publicly inaugurated in this district to-night for the higher education of engineers and shipbuilders, is due almost entirely to the President. It so happens that I have been, accidentally I fancy, associated with him in it; and it was thought the north-east coast could not possibly be allowed to lag behind the south in such a vital matter as education. One point especially occurs to me that I ought to emphasize, and it is this. The President has just to-night set an example amongst employers which I hope will be followed, that is, making public the exact terms which he is prepared to give to those young men who see fit to undergo that hard work and self denial which is associated with a systematic course

of study at college. Such young men are obviously and, nowadays, admittedly—although not long ago this would not have been admitted—worth more to their employer than those who have not gone through college, other things being equal. This is one of the features of Mr. Yarrow's regulations. Mr. Yarrow is prepared not only to forego a premium, but to pay a high wage to such a pupil. Mr. Yarrow's figures are much higher than those stated by the President, but that is largely due to his works being on the Thames, where wages are higher than on the Tyne. The whole question of the higher education of the pupil class, as distinguished from the apprentice class, seems to me to hinge upon the attitude of the employers. It is the employers who are the determining factor in this movement; if they oppose it, it will come to nought, but if they take it up, it will succeed. It would be profitable in a financial sense for employers to back up this movement. It will be profitable for them in the near future. It will not only be that, however; it will undoubtedly be one of the factors which will save the industrial situation in this country. There is no use blinking the fact that, as Mr. Morison has well said from personal experience, we are falling behind the go-ahead industrial countries of the world at present, America and Germany, and we are behind them in many ways and for many reasons. But we can put our fingers on at least one cause, and that is technical education. And it would say very little for us and absolutely belie the energy and enterprise of this north-east coast, if we did not set ourselves to try and remedy this in the best way possible and as soon as possible. I think the thanks of this Institution, and indeed of the whole community, are due to Mr. Tweedy for being the first to publicly make known what his firm, at least, are prepared to do in this matter. I am sure it is one of the greatest incentives for others to come forward and do the same, in which case we should presently have the new order of things established.

The PRESIDENT said—I would like to add one word to what has been said. The necessity for training, such as we hope will be common in a few years' time, is not only to supply our own requirements in our own works. Mr. Morison and others, including myself, who have been abroad, must have seen that

wherever you go there are young men who know at least two or three languages—who are thoughtful, studious men, who read all the English science papers, all the German, and probably all the French. These men have considerable influence, many of them. They have certainly the potential advantage of being linguists, and you find them spreading out to Australia, China and Japan—in fact, throughout the whole world you find them making their way. So that, apart altogether from the maintenance of our own English industries, we want to train up—and the training can only be completed in the works of our own country—as many men as possible to occupy important positions abroad and thus increase the prosperity of the mother country and her colonies.

Principal GURNEY,* at the request of the meeting, and by permission of the President, said—I am honoured by your invitation to offer a few remarks. I am delighted that the North-East Coast Institution of Engineers and Shipbuilders should take so enlightened and sound a view of what is desirable in the interests of their profession. There was a time when technical education was thought to be rather a fad, but from what we have heard this evening, and from what you can see in America, Germany or Switzerland, any day you may be pleased to go, we may conclude that the leading engineers recognise the very great practical importance from a profit-making point of view of getting the best trained brains procurable to superintend the work of their establishments. All I desire now to add to the discussion—I do not wish to trespass upon your patience at this late hour—is the assurance that the Engineering Department of our University College, under Professor Weighton's able direction, will be anxious to do everything that experience can suggest to advance the best interests and prosperity of the engineering and shipbuilding trades of the North-east Coast.

The resolution was carried.

* Durham College of Science.

ELECTION OF AUDITORS.

Professor WEIGHTON said—It is usual at this closing meeting to elect auditors for the Institution, and as the auditors we have hitherto had have done their work very efficiently, I have great pleasure in proposing the re-appointment of Messrs. R. W. and J. A. Sisson as auditors for the ensuing year.

Mr. GRIFFITH—I have very much pleasure in seconding the motion.

The motion was carried.

ELECTION OF PRESIDENT, COUNCIL, ETC.

The PRESIDENT declared the names of the gentlemen elected to fill the vacancies in the Council list, as follows:—

President—Mr. JOHN TWEEDY, Messrs. Wigham Richardson & Co., Neptune Works, Walker-on-Tyne.

Vice Presidents—Mr. JOHN DICKINSON (E), Palmer's Hill Engine Works, Sunderland; Mr. C. D. DOXFORD (S), Pallion Shipyard, Sunderland; Mr. W. G. SPENCE (E), Neptune Works, Walker-on-Tyne.

Honorary Treasurer—Mr. GEORGE E. MACARTHY.

Ordinary Members of Council—Mr. DAVID ANDREW (E), North of England S.S. Association, Newcastle-upon-Tyne; Mr. CHARLES A. BUSHELL, Naval Architect, Quayside, Newcastle-upon-Tyne; Mr. EDWIN GRIFFITH (E), Wallsend Slipway and Engineering Works; Mr. JAMES MARR (S), North Sands Shipyard, Sunderland; Mr. HENRY WALKER (EE), Victoria Engine Works, Gateshead.

VOTE OF THANKS.

Mr. E. J. CROSIER said—I have been requested to move a vote of thanks to the retiring members of the Council. Of course, every now and again we get assured that we in Britain are going to fall back into a very insignificant position, and there are things which show us we cannot treat these reminders with contempt. Just lately I visited Germany, and I can endorse what Mr. Morison has said about the technical and also the commercial education over there, and it is only when we think of such work as is done by this Institution that we begin to get our courage back again. Whether we look at the position of this Institution amongst other kindred societies, or the action it took in regard to the status of engineers in the Navy, or whether we think of such matters as have been brought before

us to-night in regard to education, or whether we think of the influence this Institution must have day by day in increasing efficiency in the work done in the district, we must be proud to be members of such an Institution; but, while we are proud of that, we must remember the bulk of the detail work that falls upon the members of the Council, and therefore I am sure that I am only speaking for all here in proposing a very hearty vote of thanks to the retiring members of the Council for the work they have done during their term of office.

Mr. J. H. HECK said—I have much pleasure in seconding that vote of thanks.

The motion was carried.

The PRESIDENT said—This meeting closes the present session of our Institution. The Secretary has just whispered to me that perhaps I might suggest that men who have ideas will write them down and read them at this table during the next session. We hope there will be such a deluge of papers that the difficulty will be in selecting rather than seeking them. I declare the session closed.

The meeting then dissolved.

REPORT OF THE REPRESENTATIVES OF THE NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS ON THE TECHNICAL COMMITTEE OF LLOYD'S REGISTER OF SHIPPING.

Between the date of our election and the date of the first meeting alluded to in this report, Lloyd's Register Committee was deprived through death of the eminent services of their Chairman, Mr. W. H. Tindall. Mr. John Glover (now Sir John) was elected to fill the vacancy, which he still occupies.

The proceedings of the Sub-Committee may be briefly summarised as follows:—

March 21st, 1899.

As a number of steamers had been reported damaged in the fore part by heavy weather, additional strengthening was recommended by the chief surveyor, and, being considered necessary, was agreed to.

Anchor and cable tables were extended, and scantlings for single plate rudders agreed upon.

The rules relating to cargo battens in erection and stiffening of poop and bridge fronts were made more explicit.

The proposed modification of rules to determine the working pressure of Deighton furnaces was approved.

November 28th, 1899.

At the recommendation of the Technical Committee it was agreed to defer any decision in regard to a proposed modification of the society's rules for shafting until the whole question has been carefully considered by a special Sub-Committee appointed for the purpose. The engineer members of the Technical Committee were thereupon appointed a Special Sub-Committee to consider the question and report.

The Sub-Committee were furnished with particulars of 75 sets of shafting which had given trouble. After full consideration and discussion at meetings held at York and elsewhere, the Sub-Committee at a final meeting held on January 26th, 1900, drew up a report and forwarded it to the Chairman of Lloyd's Register.

April 3rd, 1900.

It was recommended by the chief surveyor that in all vessels above 250 feet in length the after steering wheel and gear should

be protected by substantially constructed iron or steel deckhouse or hood. This was strongly opposed by your members of the Sub-Committee, but was approved later by the General Committee and inserted in the rules.

The rule as to position of fore peak bulkheads was slightly altered.

As the rules for caulking decks were not quite clear and as the practice varied in different districts, it was recommended by the Sub-Committee that all decks of steel or iron are to be caulked, unless sheathed by a properly caulked wooden deck.

The Sub-Committee's report regarding the size of shafting was considered, and rules embodying their recommendations were approved.

NOVEMBER 13TH, 1900.

Some modifications proposed in the rules relating to Brown's cambered furnace, with the view of bringing all Brown's furnaces under one classification, were considered and agreed to.

MARCH 26TH, 1901.

On account of the large number of steel ship plates failing in cold flanging, representations were made to Lloyd's Register from time to time and it was suggested by the chief surveyor that the tensile tests of steel plates intended for cold flanging should be reduced from 28 to 26 tons, which was agreed to.

The rules relating to the quality of boiler steel were under consideration and modifications and additions were made relating to the testing of rivet steel and to the testing and marking of boiler steel generally.

A proposal to introduce into the rules a specification of tests for steel shafts was carefully considered, and, after some modification, was agreed to.

NOVEMBER 26TH, 1901.

As considerable opposition had been raised to the rule requiring iron or steel deckhouses or hoods for the after steering gear, the matter was reconsidered by the Committee and amended in such a way as to conform to best recent practice.

Some suggestions from the Steel Ingot Makers' Association, with the view of removing what they considered objectionable features in the rules for testing steel, were considered and agreed to.

A new form of corrugated furnace by Messrs. Beardmore was submitted for consideration, and it was agreed that it be approved under the same conditions as Fox's furnaces.

MARCH 18TH, 1902.

Suggestions with regard to beams, engine and boiler casings of steam trawlers and filling pipes for deep tanks were considered and approved.

NOVEMBER 25TH, 1902.

A table was submitted by the chief surveyor shewing proposed increases in double bottom scantlings in boiler space of steel steamers, and after much discussion and opposition by the technical members of the Committee the matter was put to the vote and carried by 15 votes to 13, the majority being composed entirely of members of the General Committee.

On account of the difficulty in getting uniformly satisfactory rivets, Mr. Withy recommended that all rivets be branded by the maker so as to be readily traceable, and that a cold bending and hot flattening test of the bars be carried out at the works of the maker of the rivets. These proposals are still under consideration.

Proposed rules respecting the arrangements for the burning and carrying of liquid fuel were considered by the Committee, and recommended for approval.

Proposals for modification of rules, enabling a thinner combustion chamber tube plate to be used, were considered and agreed to.

The details of the various modifications and additions agreed to throughout the period covered in this report can be seen by reference to the society's rules.

Mr. Robert Thompson having been elected a member of the General Committee in the place of the late Sir James Laing, Mr. W. H. Dugdale was appointed to take his place as a representative of the North-East Coast Institution of Engineers and Shipbuilders.

(Signed) HENRY WITHY.
W. H. DUGDALE.
J. W. REED.
JOHN TWEEDY.

January 31*st*, 1903.

MEMOIRS.

MR. JOHN WILLIAM BOOTH.

Mr. John William Booth was the son of the late Mr. John Booth, one of the founders of the firm of Messrs. Joseph Booth & Brothers, Limited, Union Ironworks, Rodley. The business was commenced in a very humble way by the three brothers, Joseph, John, and Jeremiah Booth, in Town Street, Rodley, in 1847, and for many years was conducted on a comparatively modest scale, but through the energy and perseverance of its founders and their successors it has now grown into a large concern with a world-wide reputation. Mr. J. W. Booth was born in 1853. After leaving school he entered these works, passed through the shops and drawing office, working his way up till he became the head of the firm. In 1898 the business was formed into a Limited Company, and Mr. J. W. Booth was appointed Chairman, which position he held till his death, which took place at the age of 50 years on May 19th, 1903. He was elected a member of the Institution in April, 1892.

MR. JOHN McLEOD CAMPBELL.

Mr. John McLeod Campbell was born in the Island of Raaysay, Inverness-shire, on the 15th of May, 1841, and was educated at Portree. On the 2nd of April, 1857, he entered the shipbuilding yard of Messrs. Caird & Co., Greenock, to serve his apprenticeship as a ship carpenter. On leaving Messrs. Caird's employ he entered the drawing office of Messrs. Walpole, Webb & Bewley, shipbuilders, North Wall, Dublin, where he remained for some time. He then went to sea as a carpenter for two voyages in the sailing ship "Vancouver," on the completion of which he entered the employ of Messrs. The Humber Ironshipbuilding Co., Hull, as draughtsman.

In 1866 he left Hull and returned to Messrs. Caird & Co., being appointed assistant foreman carpenter, and in January, 1874, he was appointed joint-manager with Mr. Wm. Caird.

In January, 1877, he came to the River Tyne, and obtained the appointment of shipyard manager to Messrs. Wigham Richardson & Co., Neptune Works, Low Walker-on-Tyne.

In 1881 he, together with Messrs. Machintosh & Bowestead, commenced business as shipbuilders at Scotswood-on-Tyne. They did not succeed, and in 1885 the partnership was dissolved.

In 1886 he was appointed manager of Messrs. Robert Stephenson & Co's. shipyard, Hebburn-on-Tyne, which appointment he held till very recently. He was elected a member of the Institution in April, 1895.

During the autumn of 1902 he was taken suddenly and seriously ill, but after having been laid up for a considerable time, he regained his health and energy. He died suddenly at Greenock on June 26th, 1903, whither he had gone to visit his brother-in-law.

He was well known to the majority of those interested in the shipbuilding trade, and was highly respected.

MR. HENRY CHARLTON.

Mr. Henry Charlton was born at Horsley-upon-Tyne in in the year 1833, and served his apprenticeship with a firm of millwrights in that village, at the conclusion of which he journeyed to Newcastle, and obtained employment at the Elswick Works, then in their infancy, where he remained for a few years. Leaving Elswick, Mr. Charlton went as a fitter to the works of Messrs. Hawks, Crawshay & Company, Gateshead, and eventually journeyed to Italy in the service of the firm. On his return home he was appointed foreman of the fitting shop, and was acting in this capacity when he was again selected to serve the firm abroad. He spent the next two years of his life in the Caucasus, superintending the erection of bridges on the section of the Transcaucasian railway from Poti to Souram. These he successfully carried out in the face of very considerable difficulties; and on his return home was appointed to the important post of manager to his firm in the place of the late Mr. Hoskins.

In 1878, he visited Constantinople in connection with the finishing and taking over by the Turkish Government of the

great pontoon bridge (known as the Karakeni Bridge) across the Golden Horn, which had been constructed by his firm.

Under his management, Messrs. Hawks, Crawshay & Sons carried out very extensive contracts; and bridges of their manufacture still exist in nearly all the countries of the world, fulfilling the proud boast inscribed on one of them by Mr. George Crawshay's instructions—"*Quæ regio in terris nostri non plena laboris?*" When they retired from business in 1889, Mr. Charlton took over a portion of the works and started business on his own account, making a specialty of the well-known Improved Martin's Patent Anchor, so largely used by the British Admiralty and by most of the navies of the world.

Mr. Charlton joined this Institution when it was founded in 1884. In 1887, he was elected a member of Council; but on his retirement in 1890 he did not seek re-election. He was highly esteemed by all who knew him, and his business ability and upright character enabled him to rise from the fitter's bench to the highest position attainable in the service of his employers, and eventually to become proprietor. He died on February 2nd, 1903.

MR. A. S. JACKSON.

Mr. Albert Scurfield Jackson served his apprenticeship at the North-Eastern Railway Company's works, Darlington, on the completion of which he entered the works of Messrs. Blair of Stockton-on-Tees as an improver, where he remained for some time. He then went to sea as an engineer, which occupation he followed for about 7 years, acting as chief engineer in various companies, chiefly that of Messrs. Pyman, Watson & Co. On leaving the sea he joined Lloyds' Register of Shipping as surveyor, remaining there for about two years. On leaving Lloyds' Register he started business in Cardiff, as a consulting engineer and surveyor, eventually with success, having been entrusted with a considerable amount of intricate work on behalf of shipowners and underwriters. In 1896 he was appointed representative, in the Cardiff district, for Messrs. Thos. Richardson & Sons, of West Hartlepool, which position he held till his death, which took place on March 8th, 1903. He was elected

a member of this Institution in March, 1896. In addition to being a member of this Institution he was also a member of the Institute of Marine Engineers in which he took considerable interest, being a member of the Committee.

MR. FRANCIS CARR MARSHALL.

Mr. Francis Carr Marshall was born at Bedlington, in 1831, and subsequently removed to Newcastle, where his father was employed at the locomotive works of Messrs. Hawthorn, at Forth Banks.

After completing his education at Newcastle he was, in 1845, apprenticed to Messrs. R. & W. Hawthorn as an ordinary engineering apprentice, passing through the shops and subsequently into the drawing office.

After being employed for some time as a draughtsman at Messrs. Hawthorn's, he became chief draughtsman to the firm of Messrs. Thompson & Boyd of Newcastle, where he remained until the year 1860, when he took charge of the engine works of Messrs. Palmer Brothers, at Jarrow. While at Jarrow, the whole of the engine works were re-modelled and re-built under Mr. Marshall's *régime*, and a large amount of important marine engine work, including the engines for some of the largest Atlantic liners of that day, were produced from the Jarrow works.

In 1870 he left Jarrow, and, in association with Mr. B. C. Browne (now Sir Benjamin C. Browne) and others, he purchased the Forth Banks works of Messrs. R. & W. Hawthorn.

In the early seventies the firm commenced to do a considerable amount of government work, with the production of which it has in later years been so closely associated. In addition to the government engines, Mr. Marshall was responsible for the design of a large number of large mercantile engines in the early days of the new firm.

The works continued to grow and develop, until, finally, it was arranged that the whole of the marine department should be moved to St. Peters (where the boiler yard already was) and Mr. Marshall designed and constructed the present marine engine works at St. Peters.

He was prominently associated with the first introduction of the high speed marine engine for warship work, such as is now

commonly in use. One of the earlier sets of machinery of this type, designed by him, was for the cruiser "Esmeralda," built by the Messrs. Armstrong, Mitchell Company, at Walker-on-Tyne.

He also designed a number of other similar sets for various governments.

He was also associated with the first introduction of the torpedo type of engine into vessels of larger size, some vessels for the Russian government and the Italian government, engined by him, being the earliest representatives of the torpedo gunboat class.

He was largely instrumental in bringing about the introduction of forced draught on board ships, and designed some of the earlier installations which were effected. His name is also associated with the "Marshall" patent valve gear—a single eccentric gear which has been fitted to a very large number of marine engines.

When the firm of Messrs. R. & W. Hawthorn amalgamated with Messrs. Andrew Leslie & Comany, Mr. Marshall became managing director of the engine works. After the amalgamation, he was responsible for a large amount of high-power engines for vessels built at the shipyard, in addition to the warship machinery supplied to H.M. dockyards and also to Messrs. Armstrong, Mitchell & Company.

He continued in his position as managing director at St. Peters until the year 1897, when, owing to failing health, he was obliged to resign his active duties, although he remained upon the board of directors of the Company for some years after. For the last few years, however, he was a confirmed invalid, and unable to take any interest in the business.

Mr. Marshall was one of the promoters and was appointed chairman of the executive of the North-East Coast Exhibition of Naval Architecture held at Tynemouth in the year 1882. In 1886 he became a member of the Institution of Civil Engineers, and was likewise a member of the Institution of Mechanical Engineers. He was a warm supporter of the North-East Coast Institution of Engineers and Shipbuilders from its beginning in 1884 and was elected third president in 1888. He was instrumental in drawing together the Graduate members, forming them into a sub-section of the Institution and obtain-

ing for them power to hold meetings of their own at which papers of importance are read and discussed.

He died on the 24th of February, 1903.

MR. JOHN PRICE.

Mr. JOHN PRICE was born in the year 1833. He served part of his apprenticeship as an engineer with the late Mr. James Keen of Sunderland, and owing to the failure of the latter firm he completed his apprenticeship with the firm of Mr. George Clark, mechanical engineer, Sunderland. For three years afterwards he superintended the work involved in glass bottle-making, a business with which his father was connected, and in his twenty-third year he joined the Navy as an engineer.

In August, 1855, he, together with the late Mr. Robert Samuel Fraser, M.I.C.E., were appointed engineers to H.M. floating factory "Chasseur." Mr. Fraser held the position of chief engineer and Mr. Price that of second engineer. In September of the same year Mr. Price was appointed secretary to the floating factory in addition to being second engineer. He held these appointments until September, 1856, when the vessel, having finished its work at Balaclava, returned to this country and was put out of commission.

Mr. Price joined the firm of Messrs. Pile, Spence & Co., steamship builders, West Hartlepool, in the year 1858 and remained in their employ until August 1863, during which time he also, in addition to being engineer to the firm, held the post of superintending engineer to the West Hartlepool Steam Navigation Company.

In September, 1863, he was appointed chief surveyor to the Underwriters' Registry for iron vessels—Liverpool Lloyds—which post he held until March, 1876. During the period that he held this appointment he contributed very materially to the settlement of a basis on which the scantlings of iron ships were fixed and he contributed two papers on this subject to the Scottish Shipbuilders' Association. In March, 1876, he accepted the post of general manager to Messrs. Palmers Shipbuilding and Iron Company, Limited, of Jarrow-on-Tyne, which position he held until 1894. During that period great changes were

made in the works of Messrs. Palmers Company under his supervision. The blast furnace department was very largely extended, a complete steel-melting plant on the Siemens-Martin principle and an extensive bar mill were laid down, and the plate mills were also completely re-arranged and extended. The shipbuilding and engineering departments of the establishment were also brought up to date and fitted with all modern appliances, and such vessels as the "Orlando" and "Undaunted," "Pique," "Rainbow," "Retribution," "Resolution" and "Revenge," all vessels built for H.M. Navy, were constructed under his management. During his career at Jarrow the vessels launched amounted to about 650,000 tons, and in the year 1889 the tonnage launched amounted to 64,669 tons.

In 1895 the firm of Messrs. C. S. Swan & Hunter, of Wallsend-on-Tyne, was converted into a private limited liability company, and Mr. Price joined the board of directors. He maintained an active connection with the Company up to the time of his death.

Mr. Price took an active part in the municipal life of Jarrow during the period of his connection with Messrs. Palmers Shipbuilding Company, and had also been associated for many years with the 1st Durham Engineers, of which corps he was colonel. He was twice Mayor of Jarrow, and was a magistrate for the borough of Wallsend. He was prominently identified with many societies, including the Institutions of Civil Engineers, Mechanical Engineers, Naval Architects, Iron and Steel Institute, Scottish Shipbuilders and Engineers, North of England Mining Engineers, and the North-East Coast Engineers and Shipbuilders. He joined the latter Institution when it was founded in 1884, was for some time a member of the Council and afterwards a vice-president; he was also a member of council of the Institution of Naval Architects. He died on January 27th, 1903.

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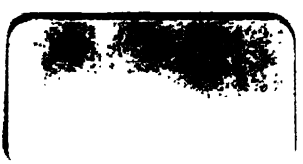
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